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The Stratigraphy of Some Lower Ordovician Formations of the Ozark Uplift

By

JAMES S. CULLISON

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UNIVERSITY OF MISSOURI

SCHOOL OF MINES AND METALLURGY

THE STRATIGRAPHY OF SOME LOWER ORDOVICIAN FORMATIONS OF THE OZARK UPLIFT

By

JAMES S. CULLISON
Assistant Professor of Geology

A Dissertation Presented to the Faculty of the Graduate School of Yale University in Candidacy for the Degree of Doctor of Philosophy.

ROLLA, MISSOURI
1944

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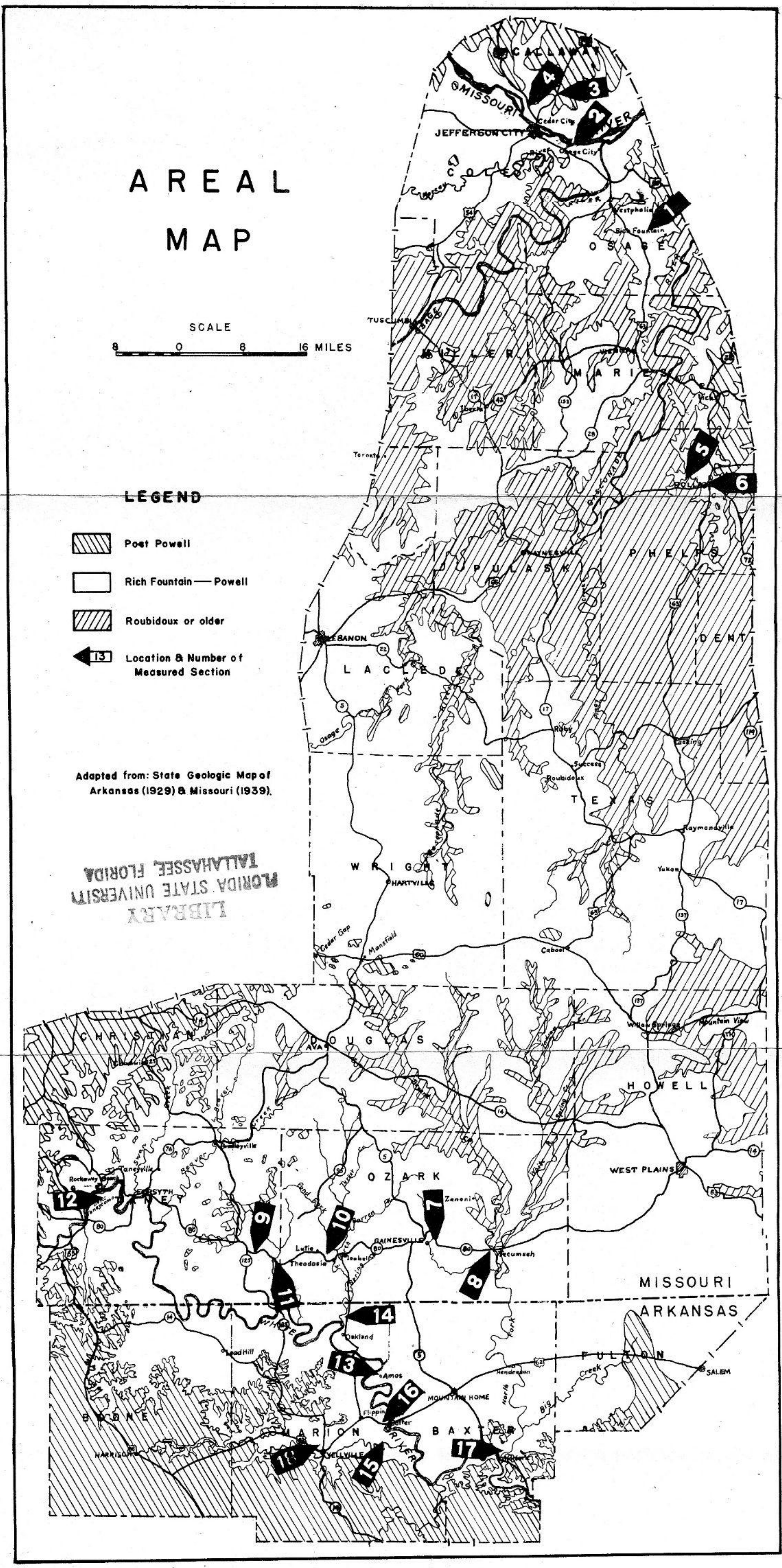

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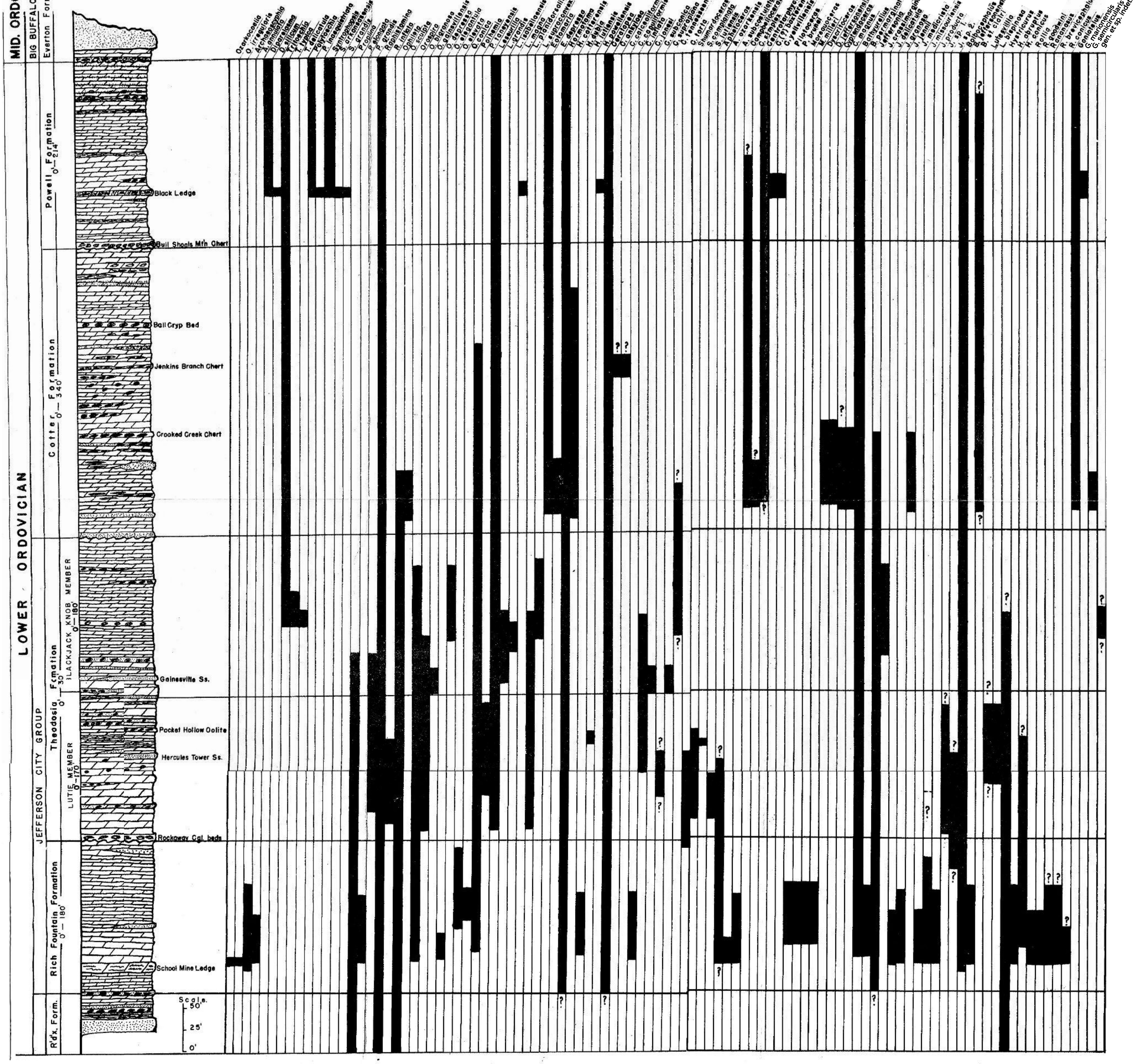
COMPOSITE SECTION AND FAUNAL DISTRIBUTION CHART



INTRODUCTION

LOCATION AND EXTENT OF FIELD INVESTIGATIONS

The area investigated is indicated on Plate I. The areal extent of the formations here discussed can best be seen on the Missouri and Arkansas state geological maps. The formations of Lower Ordovician age outcrop in a belt of varying width around the Ozark Dome. The continuity of this belt is interrupted in southeast Missouri where it is buried by formations of Cretaceous and younger ages. In south and southwest Missouri and central north Arkansas, the width of outcrop is at its maximum.

The problem has necessitated two methods of study: (1) detailed investigations in the type areas; (2) reconnaissance in the region lying between the type areas.

Detailed investigations of the Rich Fountain, Theodosia, Cotter and Powell formations have been made in the north half of the Yellville and Mountain Home quadrangles in Arkansas, and in Protem, Thornfield, and Gainesville quadrangles in Missouri. In the vicinity of Jefferson City in the Jefferson City quadrangle; and southward in the Linn, Vienna, Meramec Springs, and Rolla quadrangles; the Jefferson City Group as a whole, but particularly the lower portion, has been studied.

Reconnaissance investigations have been made in Jefferson, Ste. Genevieve, Perry and Bollinger Counties on the east side of the St. Francois Mountains. The writer has also observed numerous exposures of the formations in Laclede, Wright, Webster, Texas, Douglas, Howell, Oregon, Taney, Stone, and Barry Counties in south and southwest Missouri. In Arkansas the formations have been observed in Carroll, Boone, Baxter, Fulton, Sharpe and Randolph Counties.

RESULTS OF INVESTIGATION

1. The lithologic characters of the formations at the type localities have been recorded in measured sections for the first time.

2. The lateral extent of some key beds in these sections has been determined and the value of these beds for correlation purposes has been established.

3. The more useful and abundant species in the faunas of these formations have been described, and some faunal zones have been established.

4. The "Jefferson City" has been raised to the status of a group and the beds, heretofore included, have been grouped into two formations, the Rich Fountain and the Theodosia.

5. The cotter dolomite has been restricted to include principally those beds outcropping at Cotter, Arkansas.

6. Correlations have been established, on both a faunal and a lithologic basis, between the original type locality of the "Jefferson City" and beds of the same age in south central Missouri and north central Arkansas.

7. The presence of an unconformity between the Cotter and Powell dolomites has been supported by additional proof.

HISTORICAL SUMMARY OF PREVIOUS INVESTIGATIONS

Swallow (1855) included the formations described here as a part of his "Second Magnesian Limestone" of the Silurian system. This assemblage of beds was underlain by the Second Sandstone and overlain by the "Saccroidal Sandstone." Swallow's terminology was used for the following thirty-seven years, when Nason (1892) substituted the name Roubidoux for the underlying sandstones and dolomites, and in part for the overlying sandstone.

Winslow (1894) following Nason's lead, applied the name Roubidoux to those sandstones which lay above the "Second Magnesian Limestone" but failed to recognize that the sandstone below it was the Roubidoux formation of the type locality. To these lower sandstone beds he gave the name "Moreau" in Central Missouri, and correlated it with the "Crystal City" Sandstone in eastern Missouri. To replace the term "Second Magnesian Limestone," he applied the name Jefferson City formation and adopted as his type locality the region on the right bank of the Missouri River in the vicinity of Jefferson City, Cole County, Missouri. He applied the name of "White River limestone" to beds in southwestern Missouri, which he considered to be of equivalent age.

From 1894 to 1903, the terminology of this portion of the geological column in Missouri was further complicated by the proposal of a new name and the partial return to the old usages. "Winfield Limestone" was used by Keys (1898). Gallaher (1900) used a combination of new lithologic names and old formational names. Ball and Smith (1903) in their work in Miller County, Missouri, returned to Winslow's (1894) usage of Jefferson City. During the period from 1903 until 1911, the term "Jefferson City formation" had replaced exactly the old term "Second Magnesian Limestone" of Swallow (1855).

In Arkansas, the name "Yellville formation" was applied to rocks not only of the same age as Winslow's Jefferson City, but also to older and slightly younger beds, by Adams, Purdue, Burchard, and Ulrich (1905). Ulrich (1911) in his "Revision of the Paleozoic Systems," redefined the name Yellville, to include the beds above the conglomerate bed at Yellville, and placed the "Jefferson City" formation, in which he included more of the section than did Winslow (1894), in the "Ozarkian."

Four years later Ulrich rearranged and reevaluated the names in a series of charts published by Bassler (1915). The term Yellville was raised to series rank and included the Jefferson City and Roubidoux formations. The Cotter formation was established to include the upper part of what he had previously called Jefferson City. The name Powell was introduced to include those beds which he had previously (1911) called Yellville.

Purdue and Miser (1916), following Ulrich's terminology of the previous year, published, for the first time, descriptions of the Cotter and Powell formations in the Eureka Springs-Harrison folio. This publication includes faunal lists for the Cotter and Powell dolomites.

During 1914 and 1915, St. Clair (1928) with assistance from Ulrich, differentiated and mapped the Jefferson City, Cotter and Powell formations in Ste. Genevieve County, Missouri. This work, published in 1928, contains the faunal lists of Purdue and Miser (1916) with some additions.

In his work on heavy minerals from the sandstones of the Ozark region, Cordry (1929) published a section including all of these rocks as a part of the Jefferson City Group. This reintroduced into the literature the old usage of the term in the same sense as used by Ulrich and Bain (1905), Buckley (1908) and Ulrich (1911).

The Arkansas State Geologic Map of 1929 shows the distribution of the Jefferson City, Cotter, Powell, Smithville and Black Rock formations as interpreted from Ulrich's notes. It is of interest that this map does not definitely indicate the presence of Powell in the region of the type locality.

McQueen (1931), in his work on insoluble residues in Missouri, published a columnar section including the Jefferson City, Cotter, Powell, and Smithville formations. He discusses the lithologic character of the rocks and their insoluble residues and notes the thicknesses of the formations.

Bridge (1931) reports the Jefferson City and Cotter formations in the Eminence-Cardareva Quadrangles of Missouri but gives little description because he found them chiefly as residual chert.

The latest published information concerning these formations is that of McKnight (1935). He redefined the Cotter-Powell boundary, but did not differentiate the Jefferson City or Cotter formations and made only very general mention of the faunas.

FIELD WORK

The author's work on this problem began when he prepared his Master's thesis (Grawe and Cullison, 1931). During the field seasons of 1931 and 1932 the writer assisted Professor C. L. Dake in work on the "Canadian Problem" for the Missouri Geological Survey. Due to lack of funds and the death of Professor Dake, this work was never completed. All of the work with Dake was done in eastern and southwestern Missouri.

During the field seasons of 1934 to 1937, the writer, while engaged in geologic mapping in the Appalachian Valley of East Tennessee, experienced difficulty in mapping the upper "Knox dolomite" which is essentially of the same age as the formations discussed in this paper. The Missouri names, Jefferson City, Cotter and Powell had been introduced and used in this area by Oder (1934), but the writer abandoned all efforts to follow this usage when it became apparent that these terms were names without meaning. The faunas of the rocks involved were not described and clear detailed descriptions of their lithology in their type areas were not available in the literature.

With these deficiencies in the literature in mind, the writer continued work on this problem in the summer of 1938, and has continued the work at his own expense during the subsequent field seasons through 1941. The primary objective in the field work has been to locate and measure well exposed sections in the type areas, and at the same time to establish the faunal zones in these measured sections. The measured sections were then correlated by tracing the faunal zones and prominent types of lithology exhibited in them. The first sections studied were those best exposed in areas which Winslow (1892), Purdue and Miser (1916), Weller and St. Clair (1929), and McKnight (1935) had designated as type localities.

The United States Geological Survey topographic sheets and County Highway Planning maps, prepared under the supervision of Professor J. B. Butler of the Department of Civil Engineering of the Missouri School of Mines and Metallurgy were used as base maps. Both the Arkansas and Missouri State geologic maps were used freely.

ACKNOWLEDGMENTS

The writer wishes to acknowledge his indebtedness to: Professor Garrett A Muilenburg of the Department of Geology of the Missouri School of Mines and Metallurgy for his assistance and criticism, not only of the report but of the field work; Dr. P. E. Cloud and Dr. Samuel Ellison of the same institution for their opinions and criticism; School of Mines and Metallurgy for allowing available time and placing at my disposal all essential equipment; the United States Geological Survey for the loan of fossil collections; Dr. Josiah Bridge for suggestions, criticisms and opinions in the field; Dr. G. Arthur Cooper of the United States National Museum for his assistance on the brachiopoda; Dr. A. K. Miller of the University of Iowa for his interest and assistance with the cephalopods; Department of Geology at Yale University for their interest and suggestions and especially to Professor C. O. Dunbar whose kindness and helpful criticism have been of immeasurable assistance; Arkansas Geological survey for information supplied from their files; Geological Staff of the Little Rock Division of the United States Engineering Department for maps, permission to study their diamond drill cores, and suggestions pertinent to correlations; Missouri Geological Survey for allowing the writer the use of their well samples.

The writer also wishes to acknowledge direct assistance from Messrs. Reo Goodwin and Jerry Kendall in preparation of the collections and drawings and of Mr. Victor L. Bradford for assistance in photographing and preparing the plates.

Last but not least, the writer is deeply indebted to the citizens of southern Missouri and northern Arkansas for their hospitality, kindness and interest in the work, without which the difficulties would have been enormous.

GENERAL STRATIGRAPHY

Introductory Statement: All of the beds of the four formations here discussed have been studied in detail at numerous sections in each of a great number of localities. Faunas have been collected and their positions noted in the sections. Dolomite containing silicified fossils has been collected. Well preserved form have been etched from it with hydrochloric acid, and these have added much to the incomplete information obtained from the numerous external moulds preserved in cherts. The use of black rubber moulding compound to form casts of the external moulds has aided effectively in studying the faunas of the formations.

Insoluble residues have been prepared, in accordance with McQueen's (1931) methods, from sampled measured sections and from available well samples. Diamond drill cores have been studied where available.

The Missouri Geological Survey has kindly allowed the writer to study the cuttings and insoluble residues from wells in critical areas. From these studies the writer has drawn his own conclusions, in the light of knowledge obtained from the type sections.

Changes in Nomenclature: The term "Jefferson City" has had a multiplicity of usages in the literature since originally defined by Winslow (1892). The term should be dropped from the literature because of this. The writer retains its use however as a group term for the following reasons: (1) a boundary between the Rich Fountain and Theodosia formations is present within those beds originally defined as "Jefferson City" by Winslow; (2) the predominant usage of the term by most writers since Winslow has been in the sense of a group, even though it was not defined as such; (3) this term is too well established in Missouri stratigraphic literature to be disposed of, especially, when the beds involved are essentially the same as those of previous usages.

The term Cotter dolomite has been restricted to include those beds which outcrop in the vicinity of the type locality.

The Powell dolomite remains as described by McKnight (1935) except a greater thickness has been found in the region south and east of the Yellville quadrangle at Norfork Dam in Baxter County.

Lithology: All of the formations included in this report are predominantly dolomites or dolomitic limestones. Innumerable lenses of sandstone, dolomitic sandstone, shale, argillaceous dolomite and extremely siliceous dolomite occur in the formations. Some of these lenses are remarkably persistent over wide areas, whereas others are decidedly local and have only restricted significance as criteria for correlation. Thin sections prepared from the cherts were found to be of little value in establishing correlations. The use of heavy minerals, valuable as a means of establishing correlations within restricted areas, is not yet sufficiently well established to be relied upon for regional correlation.

Criteria of Correlation: The principal bases of correlation used throughout this work have been: (1) lithologic similarity, with reservations; (2) similarity of lithologic sequences, with allowances for variation; (3) similarity of sequences and lithology of residual cherts; (4) continuity of beds, in some instances; and, most important of all, (5) composition of the faunas found in the residual cherts irrespective of tentative inferences based on the preceding four criteria. In all measured sections the lithology has been used as a first means of correlation, but final correlation has always been based, where possible, on faunas.

Collection of Faunas: The beds of the formations included in this report are sparingly fossiliferous. The dolomites themselves rarely furnish specimens for the collector. From some beds, however, it is possible to obtain an abundance of fossils if the residual cherts are examined carefully. To the uninitiated most of the cherts appear unfossiliferous, not only because fossils are sparse but because the majority of the forms occur as external moulds and internal moulds, "steinkerns," within the chert masses. Under such conditions, recovery of complete specimens is the rare exception.

The best localities for collecting are commonly those where chemical weathering has been sufficiently active to decompose and dissolve the dolomites, thereby forming a cover of residual clay and chert. Where the slope is too steep, the clay is washed away and excellently preserved fossils are not found. Where there is too little slope, the mantle becomes so thick that it entirely covers the bed rock, thereby eliminating the possible correlation of residual chert with the parent rock. Those fossils which have been at the surface for a long time are usually worthless because they are either encrusted by drusy quartz or have been attacked, subsequent to their exposure, by solutions which have dissolved away most of their diagnostic characteristics. Most of the better specimens have been obtained from the washed surfaces of recent road cuts, where the full thickness of the residual mantle is exposed above the parent rock.

The importance of the above considerations is well demonstrated in that part of the area which borders the Missouri River. Here all of the hill tops and hill slopes are covered by loess deposits. The only exposures of bed rock are those which occur in the very steep river bluffs or in man made excavations. This condition has not allowed for the accumulation of a residual mantle of appreciable thickness. Consequently, what few fossils have been found here are either poorly preserved internal and external moulds in the dolomite or those included in chert nodules and lentils in the exposed beds.

Conditions of deposition: The formations discussed are of shallow water origin. The sandstone lenses, frequently cross bedded, ripple-marked, and at many places bearing the ridges of filled desiccation cracks which were formed in the shale beds below, support this view. Chert, shale, sandstone and dolomite lenses, not uncommonly conglomeratic, pinch out and reappear with astonishing irregularity in the same portion of the exposed sections of a restricted area, and this fact is compelling evidence that the conditions of sedimentation were commonly quite variable in short distances. Salt hoppers have been reported in the shales of two of the formations, which tends further to support the above view. This condition of shallow water deposition has made it impossible to rely, without reservations, on physical criteria for correlation. Some beds are remarkably persistent, however. These are the massive, coarsely-crystalline dolomites and silicified oölite beds. Their continuity has been established on paleontological evidence.

The above conditions lead the writer to conclude that, during this portion of lower Ordovician time, the Ozark region was covered by a broad shallow sea. The relation between land and sea level was not stable, however, except during the short intervals of time represented by persistent thick dolomite beds.

STRUCTURE

The strata outcropping in the area included in this report are mostly subhorizontal in attitude. However, there are a number of broad low anticlines and shallow synclines in the region, and normal faults of small displacement have locally produced high dips. The gentle regional dip is persistently away from the center of the Ozark uplift. This attains as much as five degrees locally, but an average of less than fifty feet per mile is the general rule.

Solution structures are common and must always be considered as a possible explanation of steep local dips. The thin lenses of insoluble sandstone and chert, common throughout the soluble dolomite formations, tend to emphasize these small solution structures. Around the edges of collapsed caverns or sinks filled with residuum, the insoluble beds stand at steep angles. The author has seen many small anticlines and synclines with dips as high as 45 degrees outcropping in railroad and highway excavations. In all cases, a careful examination of the rock below has revealed that the insoluble beds which form the structure have been let down by the irregular solution of the soluble dolomite beds below, and as a consequence, the beds above reflect the irregularity of the surface of solution below. The bedding in the underlying dolomite is commonly horizontal.

SUMMARY OF FORMATIONS

The following list of formations includes not only those which have been studied in great detail but also those which, because of unconformable relationships, lie subjacent or superjacent to those discussed in this report. These have been indicated on the accompanying map, (Plate I) as either post Lower Ordovician or pre-Jefferson City group.

PENNSYLVANIAN:

Cherokee formation:

Tan to reddish-brown sandstone and vari-colored shales, some coal .... 0-50′

(Unconformity)

MISSISSIPPIAN:

Osage series:

A number of massively to thinly-bedded cherty limestone beds and thin shale beds .... 0-6′

(Unconformity)

Kinderhook series:

Massively to thinly-bedded gray or red, non-cherty crinoidal limestone, gray to greenish-gray shale and some white to buff sandstone .... 0-75′

(Unconformity)

DEVONIAN (?)

Noel-Eureka Springs black shale:

Black fissile shale, Sylamore sandstone member present or absent at base .... 0-50′

(Unconformity)

ORDOVICIAN:

BIG BUFFALO SERIES:

St. Peter sandstone:

Massive-bedded, buff to white saccroidal sandstone........ 0-136′

(Unconformity)

Everton formation:

Gray, fine-grained, massive to thin-bedded, dense limestone sandy in part; gray to buff fine-grained dolomite, sandy in part; both interspersed with sun cracked, ripple-marked sandstone beds and lenses. Dolomite and a patchy chert conglomerate at base .... 0-400′

(Unconformity)

LOWER ORDOVICIAN

Powell dolomite:

White to buff argillaceous, relatively chert-free dolomite beds one-half to three inches thick. Contains a few thin lenticular sandstones. A thin bed of delicately and finely banded nodular chert occurs at the base. Numerous olive to gray dolomitic fissile shale beds from a few inches to eight feet thick present in lower part. Zone of very drusy porous chert 40′ to 60′ above base, associated with massively bedded, coarsely crystalline gray dolomite ....0-214′

(Unconformity)

Cotter formation:

Thick to thin-bedded, argillaceous and coarsely crystalline, light gray to buff dolomite beds separated locally by thin black to brownish-black dolomitic shale laminae. Chert, either commonly gray banded or dark colored thin lentils or massive beds, especially in the middle portion. Gray to brown sandstone lentils of variable thickness common throughout. Upper portion contains locally, argillaceous dolomite and olive-brown dolomitic shale beds. The chert of the upper portion consists chiefly of silicified spherical masses, possibly cryptozoa, ranging up to one foot in diameter. Irregularly bedded buff to reddish-brown sandstone at the base..0-340′

JEFFERSON CITY GROUP (Middle Lower Ordovician):

Theodosia formation:

Thick to thin-bedded, argillaceous and coarsely crystalline, light gray to buff dolomite. Thin bluish-green to brownish-gray shale laminations not uncommon between the beds. Contains numerous, thin, irregular, buff to brown dolomitic sandstone lentils. Two brown to reddish-brown sandstones of major significance occur. Both of these are rarely present as thick prominent outcrops in the same section. Chert abundant, light to dark gray, oölitic and non-oölitic. Chert conglomerate and breccia common near base. Large, irregular, porous, drusy masses of silica commonly weather from the massive coarse-grained dolomite near the base in the southern portion of the area..0-360′

(Unconformity)

Rich Fountain formation:

Massive to thin-bedded, white to buff to gray, fine grained argillaceous to coarsely crystalline dolomite. Thin, buff to brown dolomitic sandstone lenses and layers abundant. Chert commonly dull white to brown massive or nodular to thin lenticular. Some oölitic chert. Lower portion predominantly thick-bedded coarsely crystalline dolomite. Upper portion predominantly argillaceous dolomite, "cotton rock" ....140-180′

(Unconformity)

Roubidoux formation:

Alternating buff to reddish brown, medium grained, cross bedded, ripple marked, massive to thin-bedded sandstones and cherty, coarse to fine-grained gray crystalline dolomite. Some "cotton rock" in the upper portion.

General Relationships: The general characteristics, relationships and average thicknesses are shown in the composite section and faunal chart (Plate II). The relationships of the formations, herein described, with those which lie above them are summarized below. In the southern portion of the area, the Everton formation lies unconformably upon the Powell. Further to the north and west the Everton pinches out and the Noel-Eureka Springs black shale lies unconformably on both the Powell and Cotter. In the central portion of the area, limestones and residual cherts of the Kinderhook and Osage series lie unconformably on the Theodosia and Rich Fountain formations. Near Rolla, Missouri, residual chert and limestone of Kinderhook and Osage age, and residual quartzite containing fossils of Grand Tower (Devonian age) and sandstones and shales of Cherokee age lie unconformably on both the Theodosia and Rich Fountain formations. In the northern portion of the area, limestones of Mississippian and Devonian age as well as sandstones of middle Ordovician and lower Pennsylvanian age lie on the Theodosia formation. To discuss all of these relationships in detail is beyond the scope of the present report.

DISCUSSION OF FORMATIONS

JEFFERSON CITY GROUP

RICH FOUNTAIN FORMATION

History: This formation name, here introduced, replaces the "Jefferson City (Restricted)" of Grawe and Cullison (1931), except that slightly younger rocks are included in the new unit. The Rich Fountain formation includes the lower portion of Winslow's "Jefferson City dolomite."

The differentiation is based on the wide extent of the basal conglomerate in the overlying Theodosia formation, the great wealth of trilobite remains in the (subjacent) Rich Fountain formation and the rather striking faunal discontinuity between the two. There are also some reasons for including beds which have heretofore been called Roubidoux, but until a more complete study of the Roubidoux faunas has been made a conclusion must be withheld.

Scope of the Formation: The delineation of the base of this formation involves all of those difficulties previously experienced in drawing the base of the "Jefferson City formation." A clear cut boundary is present at the base of the type section in Osage County near Rich Fountain. The base is drawn at the bottom of the very thin silicified conglomeratic chert breccia which occurs here at an elevation of 650 feet above sea level. Unquestionably, this includes some beds which formerly have been considered a part of the Roubidoux, but this interpretation is sustained by the presence, down to this point, of fossils characteristic of higher beds in the Rich Fountain. The same contact is well exposed on U. S. Highway 63 where it crosses the Gasconade River in Maries County. Another good exposure can be seen one and one-half miles west of Tecumseh in Ozark County (See Section 8, Plate XVIII). The base of the formation lies well above the zone of *Lecanospira* of Bridge (1931) and below the "School Mine Ledge" which contains the abundant sponge fauna.

The top of the formation is drawn at the base of the conglomerate beds of the overlying Theodosia. In the type section these beds are indicated by the presence of much residual chert lying below residual blocks of a massive sandstone which the writer regards as one of the sandstone members of the overlying formation.

Areal Distribution: The Rich Fountain formation outcrops widely in the Ozark region. In the central portion of the area considered, it forms a thin veneer of dolomite above the more resistant underlying Roubidoux. To the south and north, where the valley bottoms are floored by the Roubidoux and the hilltops and high flats are covered by a veneer of the Theodosia, the Rich Fountain forms the valley walls.

The base of the formation is not exposed in Arkansas. Here the most extensive exposures are in the bottom of the valleys of the White, North Fork and Spring Rivers.

Thickness: The greatest thickness which can be attributed to this formation has been noted in the cuttings from the city well at Cotter, Arkansas. Here it is approximately 180 feet thick. At Gainesville in Ozark County, Missouri, (section No. 7, Plate XVIII) only the upper portion of the formation is exposed and a water well starting in beds at the base of this section penetrates the underlying Roubidoux 85 feet below the surface. Since the top of the formation is exposed 60 feet above the bottom of the hill along the side of Missouri Highway 80 at the base of the overlying Theodosia, the total thickness at this point would be 145 feet. In the same county, at a point where Missouri Highway 80 crosses the North Fork River, the entire lower portion of the formation is exposed, and the conglomerate at the base of the overlying Theodosia formation is present as residual chert at the top of the hill. The measured section (No. 8, Plate XVIII) begins at the top of the Roubidoux. The lower 135 feet of the section consisting of massive "cotton rock" and some sandstone, chert and crystalline dolomite is almost completely exposed. The remaining 25 to 30 feet is covered with large masses of brecciated and conglomeratic chert. The maximum thickness here cannot be much, if any, more than 160 feet.

In Taney County, Missouri, at Rockaway Beach on Lake Taneycomo, a water well has been drilled which encountered the Roubidoux formation. The cuttings from this well indicate a thickness of 140 feet for the Rich Fountain at this point.

At Rolla, in Phelps County, Missouri, (section No. 5, Plate XVII) the formation is 140 to 150 feet thick. The exposure at the type locality is on a dip slope over a distance of approximately one and one-half miles. Here the vertical component of the thickness is about 140 feet. The true thickness is probably slightly less. In a well drilled in the N. E. ¼, N. E. ¼, Sec. 36, T. 45 N., R. 11 W., Callaway County, the cuttings indicate a thickness of approximately 140 feet.

Lithologic Character: The formation as freshly exposed is predominantly dolomite. The sandstone lentils and chert beds become more prominent as weathering ensues.

Dolomite: The dolomite in the formation is of two general types: the one, massive, to medium-bedded, gray, crystalline, somewhat siliceous; and the second, massive, to thin-bedded, cherty argillaceous, white to gray to buff. These two types occur as fairly definite units but only one of them is conspicuous enough to merit designation as a member. Lee (1913, p. 35) referred the lower 80 feet of the "Jefferson City" of his report to what he called the "Pitted Dolomite member." In the Rolla quadrangle this is justified. However, when considering this same portion of the section throughout the area of this report, the "Pitted Dolomite member" of Lee ceases to be a recognizable unit. The "Quarry ledge," named by Lee (1913, p. 36), is another matter, however. It should be given a definite name as a ledge because of its extreme usefulness in mapping and correlation. The writer will hereafter refer to these massive beds as the School Mine ledge because the old name infers that this ledge contains the quarries. This was true in the Rolla quadrangle in 1913, but it is not true at the present time. The beds to be known as the School Mine ledge crop out at the experimental mine of the Missouri School of Mines and Metallurgy on the east line of the S. W. ¼, S. W. ¼, S. E. ¼, Sec. 10, T. 37 N., R. 8 W., in the Rolla quadrangle, Phelps County, Missouri. Here they are exposed in a quarry face and in the walls of the mine drifts and adit.

The School Mine ledge is a massive, medium to coarsely crystalline dolomite. On fresh fractures it is light buff to gray. When weathered, it is a darker gray and presents a rough, pitted surface. It can be differentiated from the other pitted dolomite beds occurring in this portion of the section because it is abundantly and peculiarly siliceous. The silica occurs as fine, white crystalline quartz in small pockets distributed generally through the beds. The chert content of these beds is relatively small. The insoluble residue from the outcrop is almost 100 per cent crystalline quartz and constitutes about five per cent or less of the original sample. The School Mine ledge is the only lithologic unit which has proved to be recognizable throughout the area of this report. Just west of Tecumseh in Ozark County it is represented by the only crystalline dolomite in the section. At this locality there is no suggestion of the "Pitted Dolomite member" of Lee. All of it is represented by massive "cotton rock." The nature of the outcrop of the School Mine ledge is well shown in figures 1 and 2, Plate III.

The "cotton rock," as the name is here used, is a very fine-grained, argillaceous to silty dolomite. It is distributed throughout the formation in thin layers. In the central and northern portion of the area it is locally represented by greenish blue dolomitic shale.

In the southern part of the region, the "cotton rock" layers are the most important constituents of the formation. The beds where freshly exposed are very massive, light buff to gray in color and on weathering, some of them in the initial stage become a light blue, which on continued weathering gradually changes to light buff or white. Weathering also causes the massive beds gradually to disintegrate into thin layers of about one inch in thickness, which, in turn, break up into small angular chips.

Chert: The chert of the Rich Fountain formation is predominantly dull white, compact, or porous. There are exceptions to this generalization, however. Some of the chert is oölitic in varying shades of color from bluish-gray to brown to white. One of the common types of chert masses which occurs in the beds included in the 30 feet above the School Mine ledge is shown in Plate IV, figure 1. This is a well weathered example of the chert of the principal trilobite zone of the Rich Fountain. In eastern Missouri these masses are much larger and not so porous, Plate IV, figure 2. Nodules and lentils of thickly banded gray and white chert are common and are distributed throughout the formation.

Sandstone: Within the formation, there are numerous lenticular layers of sandstone. These are rarely conspicuous on fresh exposures, and under such conditions they should, perhaps, be called arenaceous dolomites. Weathering, however, removes the dolomite and the sand content remains to form a definite bed. They vary in thickness from a fraction of an inch to 12 feet and hold no definite position in the sequence of beds throughout the area. Among the more prominent of these beds is the one about 15 feet above the School Mine ledge. The maximum observed thickness for this bed is four feet. It is distributed widely on the north side of the Ozark dome but is not present to the south, unless it is represented by a few sand grains included in the dolomite at this position in the section.

Another relatively persistent sandstone lens is one near the top of the formation. It was mapped by the writer in the Rolla quadrangle in 1929 (Grawe and Cullison, 1931). Here its thickness is known to vary from

DISCUSSION OF PLATE III

Figure 1. A general view of the School Mine ledge, showing the massive nature of the freshly exposed out-crop in the road cut on U. S. Highway 63, two and one-half miles north of Vienna, Maries County, Missouri.

Figure 2. A detailed view at the same locality as figure 1, showing the rough surface and layers of white granular silica pockets in the School Mine ledge.

four inches to 12 feet. To the north in Maries and Osage Counties this same sandstone is found locally and it was also identified in the type section of this formation.

Shale: The shale in the formation is neither diagnostic in character nor abundant in quantity. In a fresh exposure it is bluish-green in color and almost that of a calcareous silt-stone in texture. Surface weathering usually removes the calcareous content and the residue breaks down into small thin flakes. Sand grains are a normal impurity to be expected in the shale beds. Some shale beds exhibit an abundance of desiccation cracks. These shales can be classed as unquestionably primary deposits. Not all of the thin beds have desiccation cracks, however. Such thin laminae may result, in part or totally in some instances, from solution of the dolomite along bedding planes. This would allow the argillaceous content of the dissolved rock to be concentrated along the bedding planes, thus forming a deposit which would resemble a shale.

The writer has found the dolomitic shale beds in this formation of little use, even in local correlation. Those with desiccation cracks, however, imply local shallow water conditions during Rich Fountain time.

Weathering: The Rich Fountain formation weathers like the other predominantly dolomitic formations in the Ozark region. On the flats and gentle slopes a mantle of clay and residual chert accumulates. This is the common condition existing throughout Howell and Texas Counties. Mapping in these areas must be accomplished almost entirely on the basis of the character of the residual cherts. In areas where the relief is greater, the formation stands up as cliffs and steep slopes along the streams.

Of all the beds in the formation, the School Mine ledge is the most resistant to weathering. The break in the slope usually occurs at the top of these beds. Below this point in the section the slope is quite steep, forming low cliffs locally. Dolomite outcrops at the surface and the only accumulation of chert is that which has been brought down from above by mass wasting. In unusual instances where residual soil formed by weathering is present, it is of a red color and contains a high percentage of angular, singly terminated, euhedral quartz crystals of small size.

Immediately above the School Mine ledge, the surface slope decreases and is interrupted by occasional low rises held up by pitted dolomite. The surface is covered with float of nodular chert and a thin yellowish-brown to brownish-red soil. This surface is the usual area for collecting fossils from this formation.

Above the last of the pitted dolomites, the slope again steepens over that portion of the section underlain by "cotton rock." The residuum is usually thin, buff to brown in color and contains not only chert fragments but also blocks of sandstone float, masses of limonite, pseudomorphic after pyrite and small thin plates of "cotton rock."

The top of the formation is commonly covered by an accumulation of residual chert derived from the conglomerate at the base of the overlying Theodosia formation.

A summary of the above discussion can be observed in the generalized section, Plate II, of this report.

Stratigraphic Relations: The relation of this formation to the underlying Roubidoux strata is not as yet definitely understood. The lower boundary, as

DISCUSSION OF PLATE IV

Figure 1. One-half of a fossiliferous chert nodule characteristic of the lower Rich Fountain, immediately above the School Mine ledge. Scale, X .5. Obtained from roadside in the N. E. ¼, S. E. ¼, Section 7, T. 41 N., R. 9 W., two miles west of Freeburg, Osage County, Missouri.

Figure 2. Massive chert from the same zone as figure 1. Scale, X .33. Obtained from M. S. M. locality 75.22 in the N. W. corner of the S. W. ¼, N. W ¼, section 18, T. 39 N., R. 6 E., Jefferson County, Missouri.

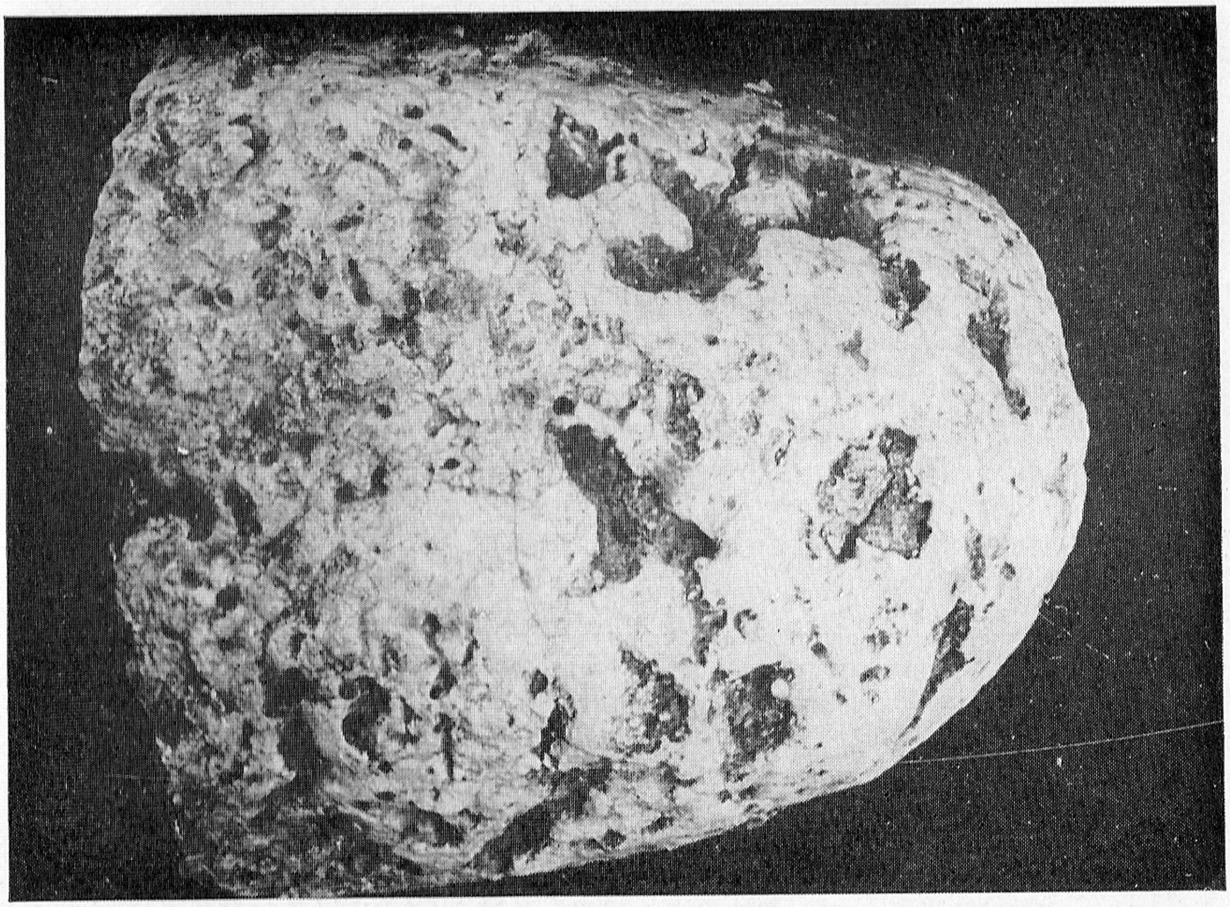


Fig. 1

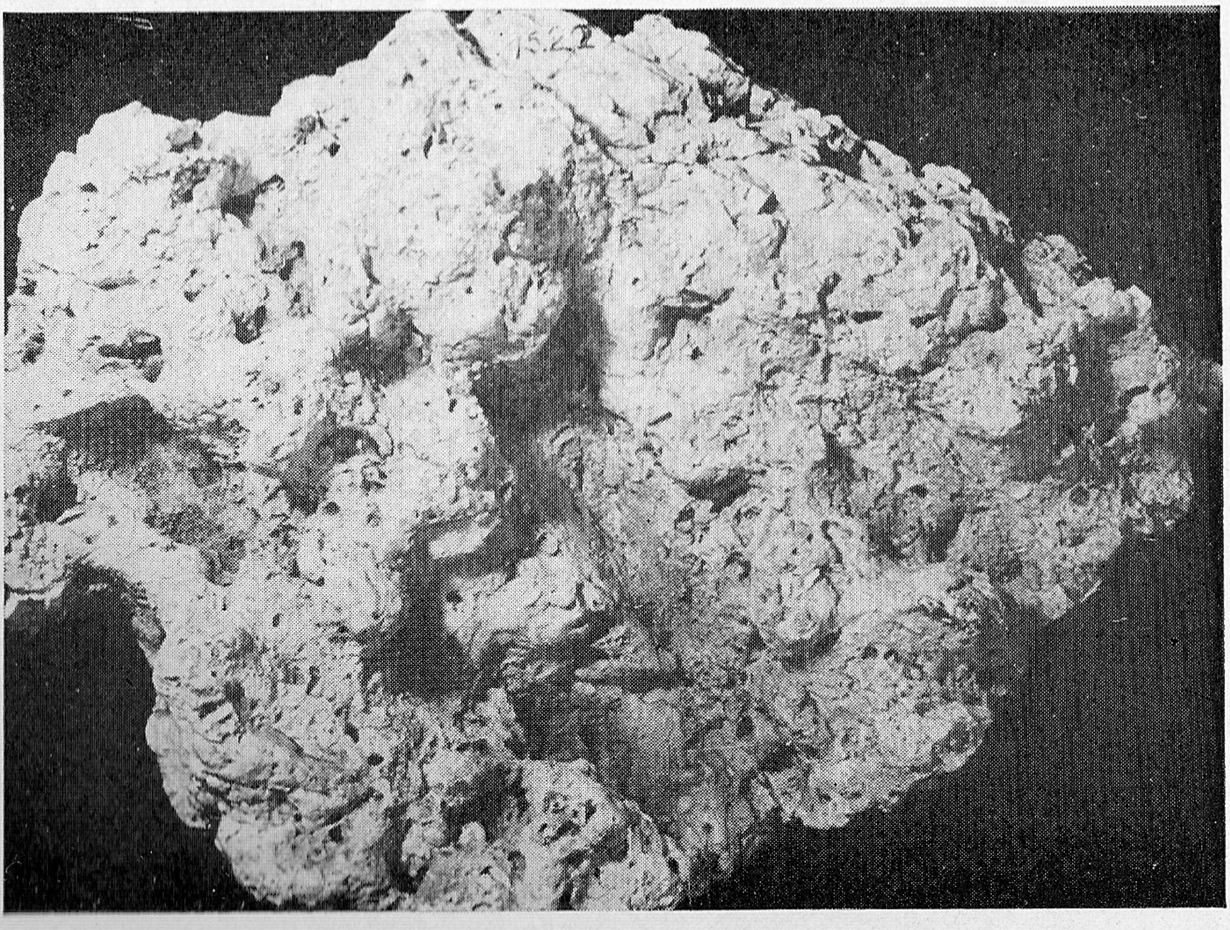


Fig. 2

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drawn by Lee (1913) in the Rolla quadrangle, is decidedly arbitrary. As it is drawn by the author at the type locality of the Rich Fountain formation it is purely a lithologic boundary of convenience. The boundary as drawn by Dake on the Missouri State Geologic Map in 1922 was based almost entirely on lithology and the presence of the gastropod genus *Lecanospira* below. Until a thorough study of the Roubidoux formation and its fauna is made, a final decision regarding the boundary and relationships must be withheld. However, as the boundary is drawn in most areas where the contact is now exposed, the relationship seems to be one of conformity.

The Rich Fountain formation is overlain unconformably by the Theodosia formation.

Paleontology: The characteristic fossils of the Rich Fountain formation are trilobites. Of these, various species of the genus *Jeffersonia* are quite abundant. *J. producta*, *J. granosa* and large specimens of *J. missouriensis* appear to be restricted to a zone lying above the School Mine ledge and extending upward in the section for a distance of approximately forty feet. Of the cephlapods, the genera *Moreanoceras* and *Pilotoceras* as well as *Aphetoceras subcostulatum*, *A. ozarkensis* and a large orthocerocone species as yet undescribed, seem to dominate this zone at some localities. The gastropods in this zone are numerous. The more common are *Hormotoma dubia*, *Orospira depressa*, *O. elevata*, *O. conica* and *Ceratopea capuliformis*. All of the above mentioned forms have been found in association with one another in this zone, preserved in chert of various types. The most common of the cherts is that indicated in Figure 1, Plate IV. Immediately below this zone, rarely if ever more than 12 to 15 feet, is the *Ozarkocoelia irregularis* zone which is in the upper beds of the School Mine ledge. *Archeoscyphia annulata* is also present here but ranges upward into the zone above.

The upper portion of the Rich Fountain does not appear to contain any dominant faunal zones. Occasionally specimens of *Orospira elevata* and a few poorly preserved specimens of *Hormotoma* are encountered.

Age and Correlation: The Rich Fountain of the type region has not been directly traced into beds included in this formation in the southern portion of the area. Stratigraphic position, lithologic similarity, and especially, paleontological evidence, support the conclusion that the Rich Fountain has at one time extended over the Ozark Dome.

The formation has faunal equivalents in the Appalachian valley in the lower part of the "Post-Nittany" division of the "Knox dolomite," a unit of which has been called the Forked Deer formation by Hall and Amick (1939) and Jefferson City by Oder (1934). Dake and Bridge (1932) figure a specimen of (*Calathium*) *Archaeoscyphia* from the Ellenberger limestone of Texas which appears to be very closely related to *Archaeoscyphia annulata* of the Rich Fountain. The faunas thus far described from the Shakopee dolomite of Wisconsin and Minnesota do not suggest any equivalence of that formation with the Rich Fountain. Bridge (1931), basing his opinion on the list of species published by Weller and St. Claire (1928), suggests the correlation, in part, of what is here called the Jefferson City group with the Shakopee dolomite of Wisconsin, the Newala limestone of Alabama and with the upper part of Division C of the New York Beekmantown. Apparently the part to which he refers is the upper part which is here designated as the Theodosia formation.

DISCUSSION OF PLATE V

Figure 1. Massive Cryptozoa like masses of chert from the middle Rich Fountain, obtained six miles south of West Plains, Howell County, Missouri.

Figure 2. A block of dolomite from the School Mine ledge, containing *Ozarkocoelia irregularis*, obtained from the adit of the School Mine at M.S.M. locality No. 72.53.

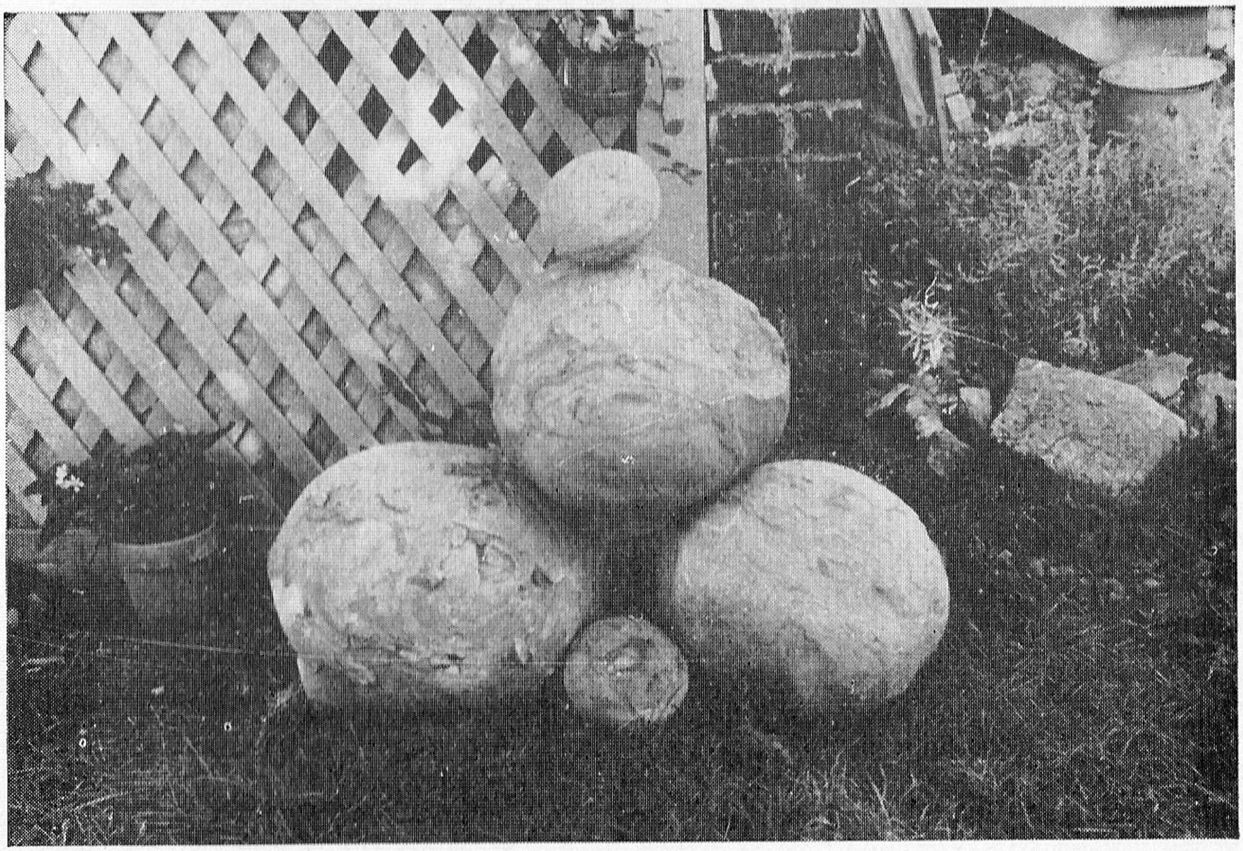

Fig. 1

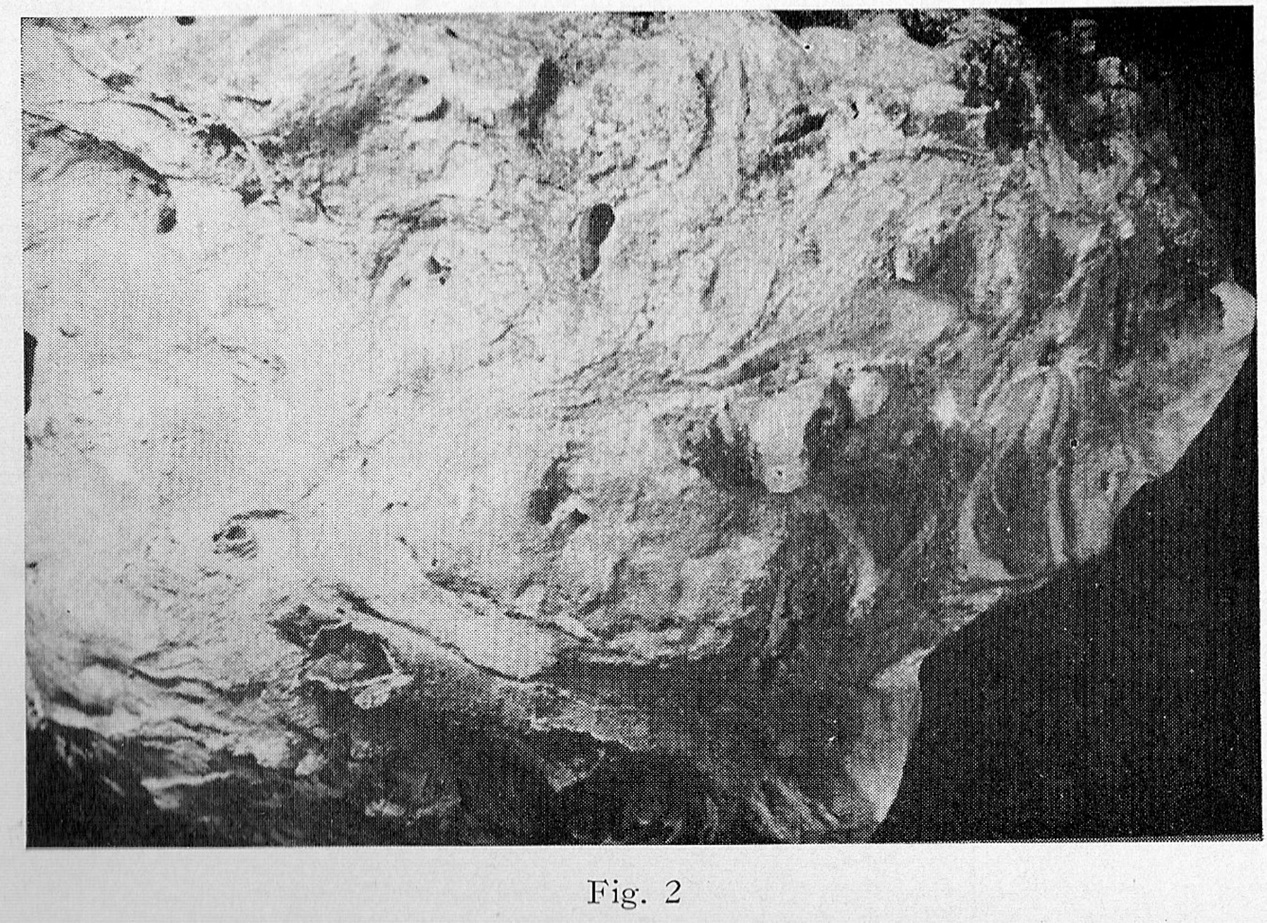

Fig. 2

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THEODOSIA FORMATION

History: This formation is being defined for the first time. It includes beds which have been previously called "upper Jefferson City" and "lower Cotter dolomite" by various workers. The type section is not located at a single exposure, but is composed of two sections exposing two separate members of the formation. These are the Lutie and the Blackjack Knob members. The former is the lower part of the formation and outcrops between the Post Offices of Theodosia and Lutie in the western part of Ozark County, Missouri. The details of this section are shown in section No. 10, Plate XIX. The Blackjack Knob member outcrops on the north side of Blackjack Knob (Protem quadrangle) in eastern Taney County, Missouri (See section No. 9, Plate XIX). The thickness of the formation exceeds the average relief of the region, consequently a complete, continuously exposed section is unlikely. The only probable place where such a section might exist would be in the vicinity of Rockaway Beach on Lake Taneycomo in Taney County, Missouri.

Scope of the Formation: The base of the formation is drawn at the base of the chert conglomerate beds which will be called Rockaway conglomerate beds from the locality of Rockaway Beach, Lake Taneycomo, Taney County, Missouri. The top of the formation is drawn at the base of a very irregularly bedded sandstone which outcrops on the east and north sides of Blackjack Knob at an elevation of 1090 feet. This sandstone lies below a conglomeratic dolomite and a coarsely crystalline fossiliferous dolomite of the lower Cotter formation in this area. To the south, in the region embracing Bull Shoals Mountain, Pine Mountain and Long Mountain in the northern part of the Yellville quadrangle, a similar sandstone is present, lying between the same faunal zones as at Blackjack Knob. In sections 32 and 33, T. 22 N., R. 14 W., in the Thornfield quadrangle, Ozark County, Missouri, we again find a sandstone with similar relations above and below.

Paleontologically, the boundaries are drawn at the base of the *Orospira bigranosa* zone and above the top of the *Orospira elegantula* zone. No species of the genus *Orospira* have been found by the writer above the upper boundary. Other faunal zones indicated in Plate II define the boundaries more precisely.

Areal Distribution: The Theodosia formation forms the tops of the higher hills in the northern part of the area and is the principal cliff forming dolomite along the White River valley between Lake Taneycomo in Missouri and Bull Shoals Mountain in Arkansas. The beds found at the higher elevations in Howell, Ozark, Taney, Douglas and Wright Counties in the central southern part of Missouri and at the lower elevations in northern Fulton, Baxter, Marion and Boone Counties in northern Arkansas are principally of this age. Exceptions to this broad generalization are the beds of Carboniferous age which are found on the tops of some of the higher hills.

The Lutie member of the formation is more wide-spread on the outcrop in Missouri, whereas the Blackjack Knob member is the more widely distributed along the boundary between the two states and in Arkansas.

Thickness: The thickness of the formation is the total thickness as measured at Blackjack Knob and between Theodosia and Lutie. The total thick-

DISCUSSION OF PLATE VI

Figure 1. A generalized view of the Rockaway conglomerate bed at the base of the Theodosia, as exposed in the section one mile north of Oakland, Marion County, Arkansas.

Figure 2. A detailed view of a silicified mass of the Rockaway conglomerate. From the base of the Theodosia formation at M. S. M. locality 106.26 in the N. E. ¼, Sec. 32, T. 23 N., R. 15 W., Ozark County, Thornfield quadrangle, Missouri.

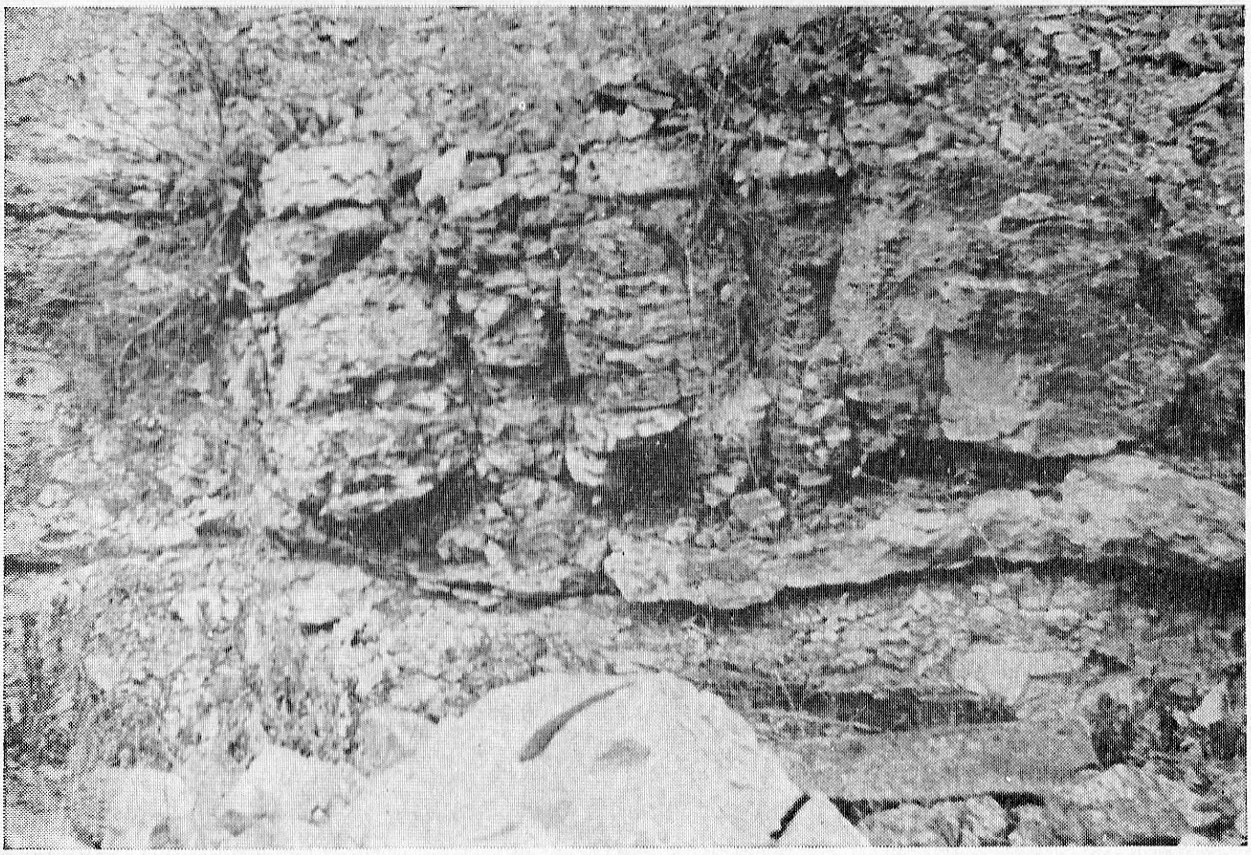

Fig. 1

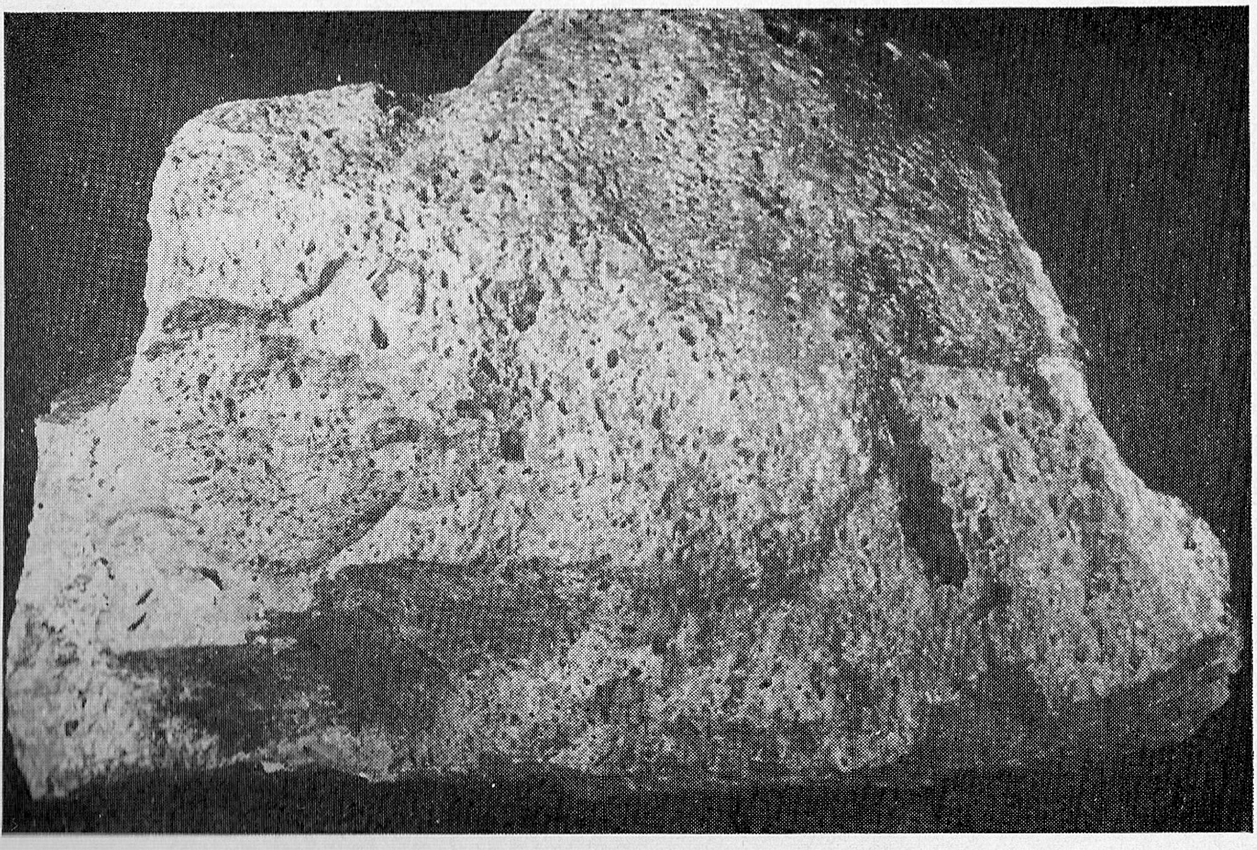

Fig. 2

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ness as shown in these two correlated and measured sections No. 9 and No. 10, Plate XIX, is 360 feet. The top of the Lutie member is drawn in the covered interval shown in section No. 10. It lies slightly above the mid-point between the heavy Pocket Hollow oölite bed and the Gainesville sandstone bed. In the section measured near the mouth of Little North Fork River, north of Oakland, Arkansas, section No. 14, Plate XXI, this contact is well exposed and is characterized or marked by shale beds and a thin, conglomeratic, desiccation cracked and ripple marked sandstone. Here the thickness of the Lutie member is 170 feet. Near Lutie it is also 170 feet. The thickness of the Blackjack Knob member, section No. 9, Plate XIX, at that locality is 190 feet. The cores obtained by the U. S. Engineering Department in the preliminary drilling at the site of a proposed dam at Bull Shoals Mountain show a thickness of 324 feet for the formation. The thickness of the Lutie member here is 170 feet and that of the Blackjack Knob member is 154 feet.

In the northern part of the area, field work has not disclosed any locality where the upper portion of the Theodosia formation is exposed, consequently no total thickness is known. It appears, however, that the Lutie member is somewhat thinner in this area than it is to the south.

Lithologic Character: The lithology of the formation is predominantly dolomite, principally of the "cotton rock" type, although some massive crystalline dolomite beds are known in the southern portion of the area. The formation contains a number of beds which are diagnostic and of considerable importance in correlation.

Rockaway Conglomerate: In the strict sense of the term, perhaps, these beds might be called breccias. They are composed of a variety of material. Commonly they contain angular and slightly rounded chert fragments rarely exceeding two inches in diameter. These pieces of chert are rudely banded and appear to be fragments of silicified cryptozoa. Small fragments of sandstone and innumerable sand grains are common constituents. At some localities the conglomerate is little more than a mass of sand grains cemented by chert and crystalline quartz, which contains angular or slightly rounded cavities. Some of these cavities are empty; others contain remnants of dolomite pebbles which have been reduced to their present size by solution, and yet others are lined or almost filled with quartz druse. Examples of this are shown in figures 1 and 2 of Plate VI.

These beds are not one continuous thickness of conglomerate but are commonly separated by "cotton rock" or crystalline dolomite. The greatest known number of beds at this point in the section occur at Rockaway Beach (See section 12, Plate XX). The number varies from place to place. Throughout the southern tier of Missouri counties and extending up into Wright County the conglomerate is found in considerable abundance, but in the northern part of the area and to the east in Jefferson County, Missouri, it is not recognizable on the basis of lithology alone. Here it can be located, once the sequence of the faunal zones has been established.

Immediately above the Rockaway conglomerate there is a massive, crystalline dolomite, commonly more or less chert free, which weathers to a rough surface. Near the top of this ledge one bed about three feet thick weathers to porous masses of chert and crystalline quartz (See figure 1, Plate VII). This bed outcrops extensively in Ozark County and has been

DISCUSSION OF PLATE VII

Figure 1. A generalized view showing the masses of lower Theodosia spongy chert on the hillside west of Theodosia, Ozark County, Missouri.

Figure 2. At the same locality as Figure 1, showing the cavernous nature of the coarsely crystalline dolomite which produces the porous chert.

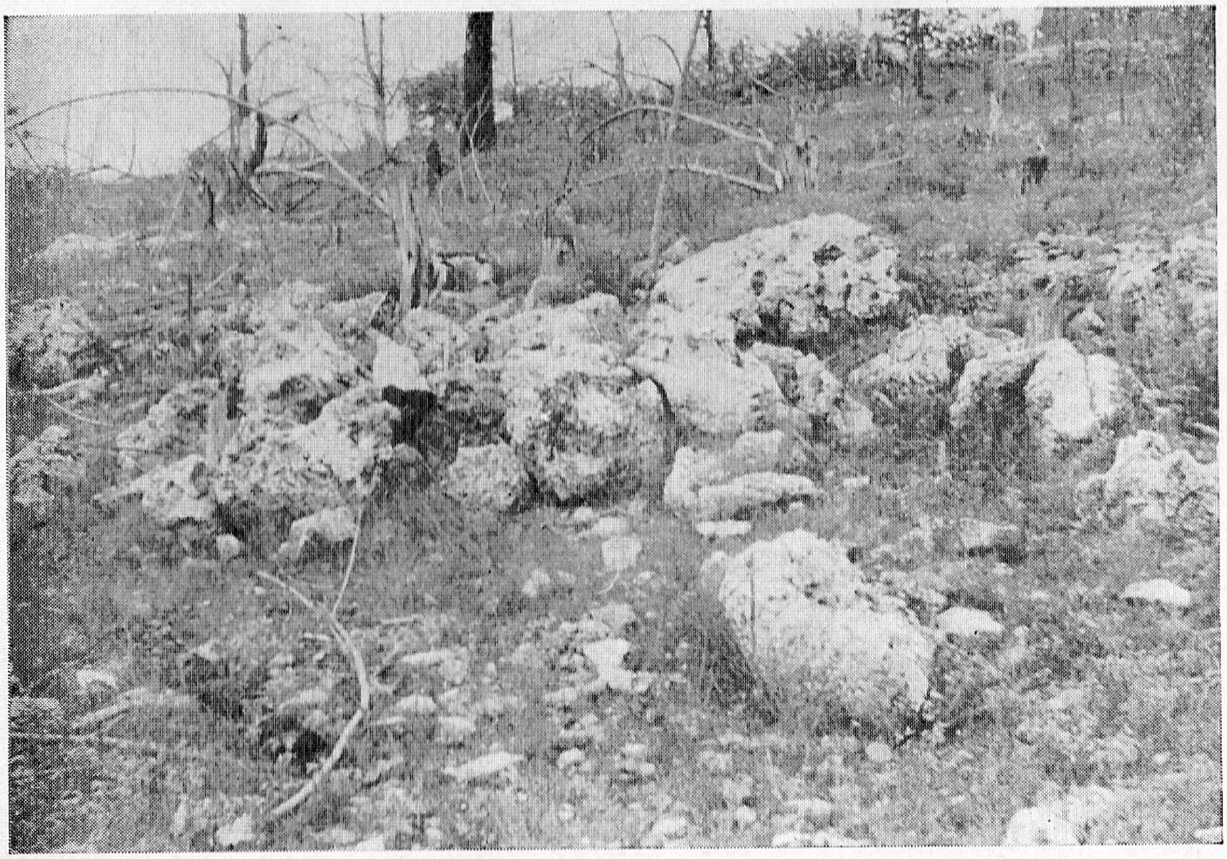

Fig. 1

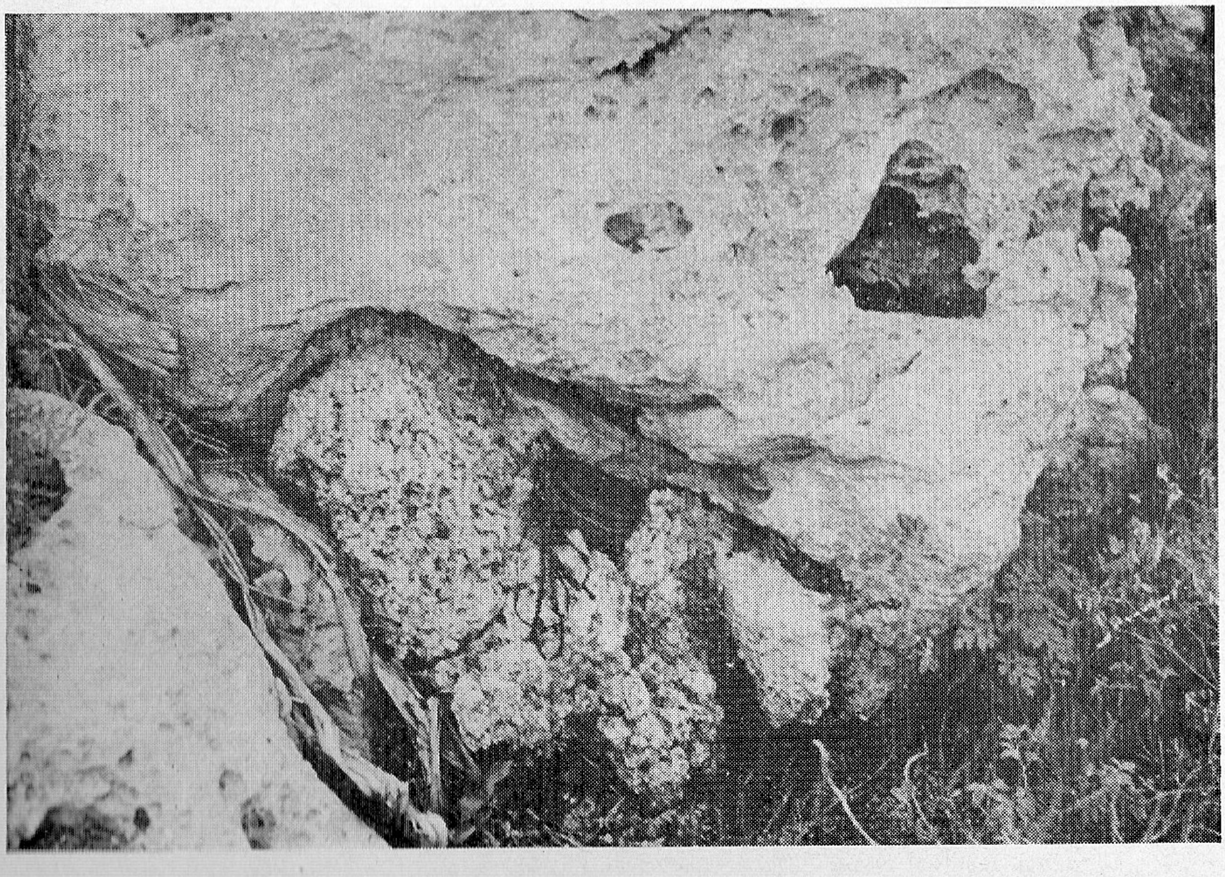

Fig. 2

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recognized in sections as far north as Wright County. The lithology of the parent dolomite, its topographic expression, and the abundant growth of *Juniperus virginiana* which it supports, produce a close resemblance to the common appearance of the School Mine ledge of the Rich Fountain formation. The absence of the typical fossiliferous chert nodules, so characteristic of the beds which lie above the School Mine ledge of the Rich Fountain, serves as a criterion for the field man to distinguish them.

Hercules Tower Sandstone: The maximum observed thickness for this sandstone is 10 feet. The sandstone is well exposed on Missouri Highway 125 south of Brush Creek about midway between the village of Hercules and the Hercules fire lookout tower, Taney County, Missouri. It is very massive, red to reddish-brown, medium-grained and friable, and at this locality has been much weathered. This is the sandstone usually referred to as the "Swan Creek sandstone" by the Association of Water Well Drillers in the state, the name having been suggested orally by Ulrich and continued by word of mouth, not in print, since his first pronouncement. The writer would have liked very much to use this name and the original locality on Swan Creek, but the name has been pre-occupied twice. Consequently, the use of the local term would have little or no significance outside of Missouri. Under normal conditions names should not be applied to such thin beds as the sandstones and cherts here referred to, but in a section which is composed of indistinguishable dolomites, sandstone beds are likely to be given more consideration than is normally justified. This tends to lead one into the error of attempting correlations on the presence and character of sandstone beds. Experience has taught the writer that correlations cannot be made on the lithology of the sandstone alone, because the only characteristic in which these sandstones vary is thickness and this occurs in the same bed. The sandstone is only the "flag" so to speak, which warns one to search for the identifying fossils.

The Hercules Tower sandstone is distributed extensively through Taney, Christian, Douglas, and Wright Counties, Missouri. It occurs also in Ozark and Howell Counties, Missouri, and Baxter and Marion Counties, Arkansas. In these latter counties, however, it is not as thick and prominent as in those previously mentioned. In the northern portion of the region, this sandstone is not conspicuous. There are other sandstone lenses which, because of local thickening, are more conspicuous and the fact that they are thick and prominent has a tendency to lead some workers to consider them correlatives of the Hercules Tower bed. The writer is convinced of the identity of a sandstone bed only when a specific fauna is associated with it. Some of these faunas are indicated in Plate II.

Above the Hercules Tower sandstone there is a very diagnostic chert. This is called the Black and White chert because of its color. A specimen, somewhat larger and more compact than average, is illustrated in figure 1. Plate VIII. Weathered specimens are much rougher and stained a reddish-brown on the surface, figure 2, Plate VIII. It is composed almost entirely of the gastropod *Hormatoma lutiensis* and occasional specimens of *Shumardoceras complanatum* (Shumard). No chert similar to this has been noted in any other portion of the lower Ordovician section of the Ozark region. The chert mass may be either compact or somewhat porous and granular. On fresh fractures it will be noted that the grayish-black or bluish-gray spots in

DISCUSSION OF PLATE VIII

Figure 1. An illustration of the massive nature of freshly exposed "Black and White" chert, of the Lutie member of the Theodosia formation, Theodosia, Ozark County, Missouri. (X .4)

Figure 2. A partially weathered and freshly fractured specimen of the "Black and White" chert bed of the Lutie member of the Theodosia formation from just north of the mouth of Pond Fork, one mile north of Theodosia, Ozark County, Missouri.

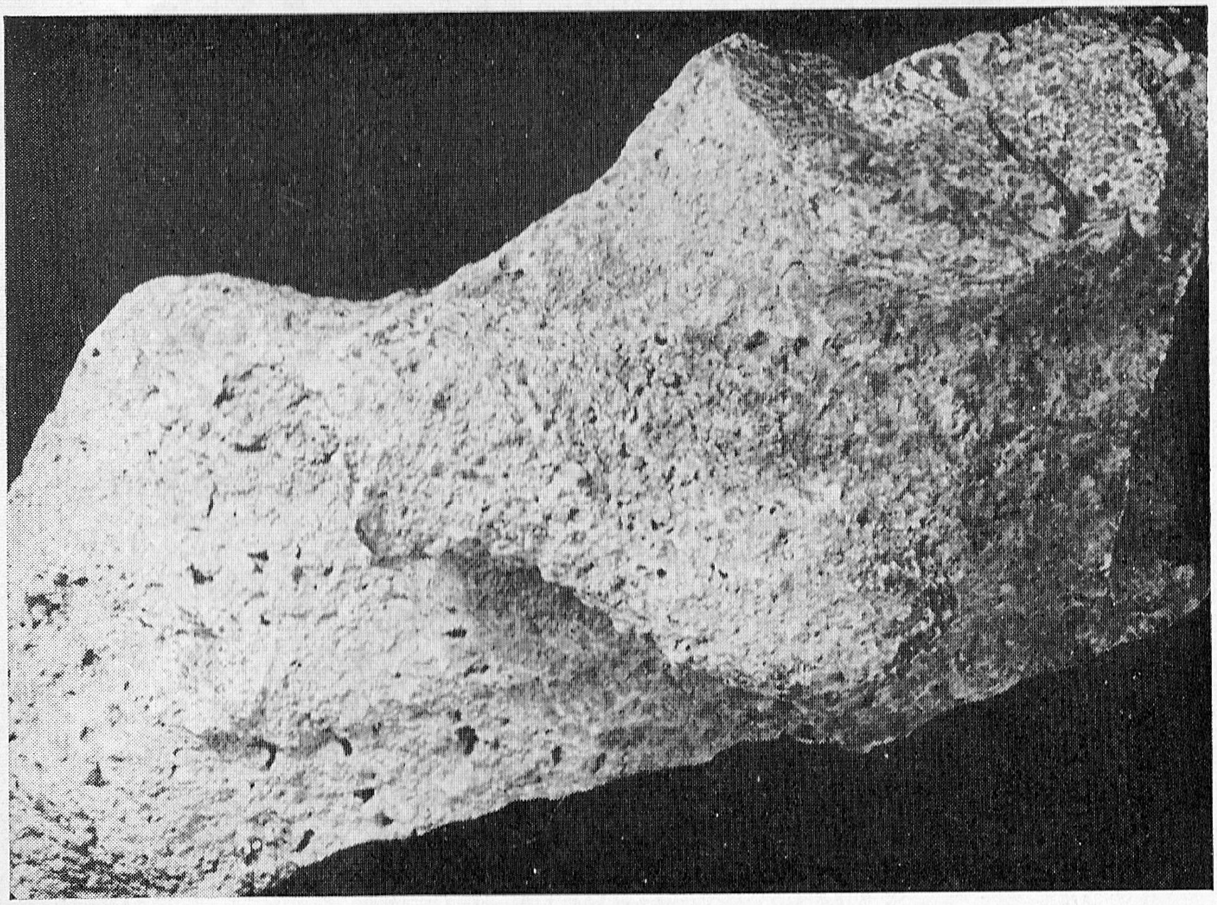

Fig. 1

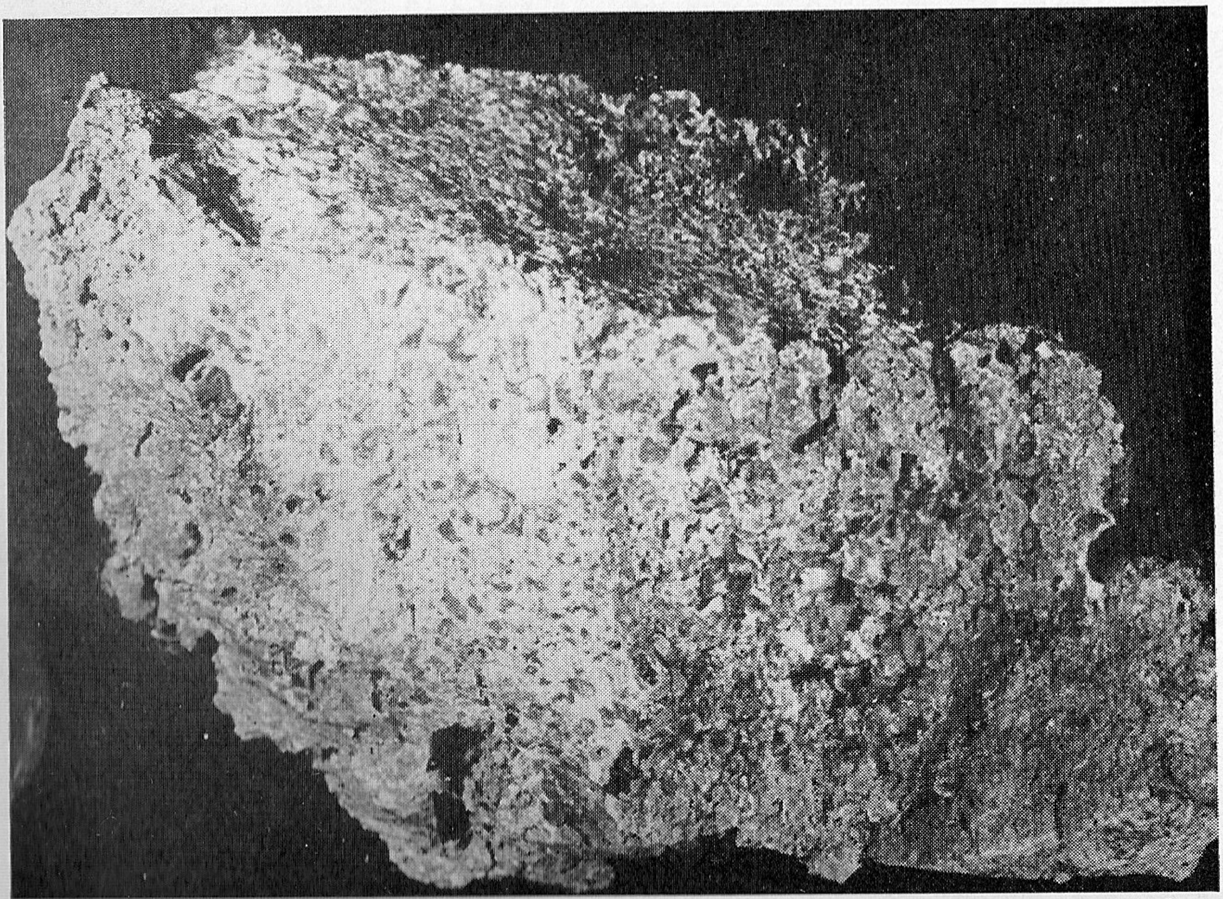

Fig. 2

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the white groundmass are chert fillings of high spired gastropods. This layer has been observed all over the southern portion of the region where these beds outcrop. It is more dependable for correlation purposes than is the Hercules Tower sandstone below.

Between this layer and the next of correlative value above, there are numerous beds of the common, finely crystalline dolomite and "cotton rock," above which the Pocket Hollow oölite occurs. This bed of medium to coarse grained oölitic chert is present over an extensive area of the southern portion of the region. It was first noted by the writer in the fall of 1938 while measuring the section north of Oakland, Arkansas. During the following summer it was traced widely. Its presence just below the top of the Lutie member of the Theodosia formation is valuable as an aid in recognizing the covered belt which commonly marks the top of this member. The bed is sandy near the base and strongly oölitic at the top. At the bottom of South Pocket Hollow in the S. E. ¼, Sec. 29, T. 22 N., R. 14 W., Thornfield quadrangle, Ozark County, Missouri, the source area of the name, this oölite bed is three feet thick and floors the valley over a broad area. It has been used as a basis of correlation between a number of the measured sections and has been found to be invariably below the coarsely crystalline, *Orospira*-bearing dolomite, and above the "Black and White" chert previously mentioned.

North of Oakland, Arkansas, section No. 14, Plate XXI, the top of the Lutie member of the Theodosia formation is marked by the thin desiccation cracked, ripple marked sandstone previously mentioned. This is the base of the Blackjack Knob member of the Theodosia and lies just below the gray coarsely crystalline *Orospira*-bearing dolomite. Above this dolomite and practically grading into it, is the Gainesville sandstone bed.

The Gainesville sandstone is well exposed at the top of the Gainesville section No. 7, Plate XVIII, just east of the county seat of Ozark County on Missouri Highway 80. Here the sandstone is at least eight feet thick and the interval between it and the *Orospira* dolomite is a few feet more than in the Oakland section. South of Oakland, Arkansas, where the Pace Ferry road first reaches the river bottom, and from there up to the state line and also in the section at Theodosia (No. 10, Plate XIX) this sandstone contains external moulds of *Orospira*. It is one of the few Ordovician sandstones in the state of Missouri which has been found to be fossiliferous.

Above this, the next bed of significance is a massive, fossiliferous chert zone which is usually recognized by its fossil content rather than by its lithologic character. In a weathered state it is sandy, oölitic, reddish brown to gray, but when freshly exposed is usually yellow to cream in color on the outside and bluish-gray on the fresh fracture. Its position in the section, like all the other beds here discussed, is noted in the generalized section, Plate II.

The upper portion of the Blackjack Knob member is a monotonous sequence of alternating gray, slightly cherty, finely crystalline dolomite and argillaceous dolomite.

Weathering: The Theodosia formation weathers to a thin, yellowish-red, cherty clay soil. The "cotton rock" zones commonly form areas which are only sparsely covered by vegetation or are practically barren. These are spoken of locally as "balds" when they occur on the hill tops and "glades" when they are a part of the hill slope. The more resistant beds, sandstones and cherts, are found at the breaks in the slopes. They do not hold up the relatively level high flats in the region, however. The topographic expression of the formation differs very little from that of the upper Rich Fountain beds in the northern part of the area.

Stratigraphic Relations: An unconformity between the Theodosia strata and the underlying Rich Fountain beds is indicated by the Rockaway conglomerate beds. The overlying Cotter dolomite is also thought to rest unconformably on the Theodosia formation, but the evidence is inconclusive. This contact will be considered further in the discussion of the Cotter dolomite.

Paleontology: The Theodosia contains a number of well marked faunal zones. Near the base, within the thirty feet immediately above the conglomerate beds, there is a great abundance of fossils. Of these the two of most significance and of greatest use are *Leseurilla planidorsalis* and *Ceratopea torta.* Associated with them are *Orospira bigranosa,* a number of undescribed species of *Orospira, Shumardoceras lutiensis* and a number of high spired gastropods.

Above this, in the bed here called the "Black and White chert," there is a great abundance of *Shumardoceras complanata* and *Hormotoma lutiensis.* Silicified fragments of specimens of these two species practically constitute this chert bed. Associated with them one occasionally finds poorly preserved specimens of a low spired gastropod resembling somewhat the genus *Polhemia.*

In the coarsely crystalline dolomite above the "Pocket Hollow oölite" and below, within and immediately above the Gainesville sandstone bed, there is a very abundant *Orospira* fauna. Of these *O. bigranosa* and *O. gainesvillensis* are the most common. A number of species of *Ceratopea* have been found in this zone, and among them *C. subconica, C. jonesi,* and *C. supraplana* are the most conspicuous.

Approximately 50 feet above the Gainesville sandstone bed, or 100 feet above the Pocket Hollow oölite, is the *Leseurilla isabellaensis* and *L. grandis* zone. Here we also find *Tritoechia typica, T.* cf. *delicatula, Orospira bigranosa* and *O. elegantula.* At some localities *Ceratopea* cf. *tennesseensis* has been found in these beds. *Jeffersonia crassimarginata* appears to be restricted to this zone.

Age and Correlation: The fauna described by Stauffer (1937) from the Shakopee dolomite at Cannon Falls, Minnesota, appears to have more genera in common with the Lutie member of the Theodosia formation than with any other portion of the Missouri section. In the Theodosia formation the genus *Orospira* reaches its climax in the number of species present and the high ornamentation which it attains. This genus reaches a similar stage of development in the upper Knox dolomite of Virginia. It is probable that the beds here included in the Theodosia formation are equivalent to those which Bridge (1931, p. 129) included in his Jefferson City-Cotter formations, which he correlated with the Newala of Alabama and the upper part of Division C of the New York Beekmantown.

COTTER DOLOMITE

History: The name Cotter dolomite was coined by Ulrich (1915). The strata to which it was applied were first described by Purdue and Miser (1916) in the Eureka Springs-Harrison, Arkansas, Folio. They included in their description of the formation all of the rocks exposed below the Powell formation in this area. Weller and St. Clair's (1928) descriptions of the formation are not usable in the southern portion of the state, and the writer has included at least the lower one-half of what they call Cotter in his new Theodosia formation. McKnight (1935) was the first to give a definite upper boundary for the formation in the type region. This boundary is slightly higher in the section than the one used by Purdue and Miser. McKnight did not attempt to draw a boundary between the Cotter and the underlying starta but included everything below the base of the Powell in the "Jefferson City-Cotter dolomite."

Scope of the Formation: The type area, as stated by the above mentioned authors, is in the vicinity of Cotter, Arkansas. A type section has never been designated in the type region. The best exposures which the writer was able to find are those described in sections No. 15 and No. 16, Plate XXII. The base of the section exposed in the area to the north and especially well at Blackjack Knob (section No. 9, Plate XIX) is not exposed here, but information gained from a study of the cuttings of the city water well at Cotter and from the location of the fossil zones, section No. 15, indicates rather definitely that it is approximately at river level or within the limits of the thickness of the broad alluvial plain of the White River valley in this vicinity. This section, starting at the valley bottom just upstream from the west end of the White River bridge at Cotter and extending to the top of the hill westward along U. S. Highway 62, is here designated the type section of the Cotter. In addition, the section starting at the level of Crooked Creek below the bridge and extending north along Arkansas Highway 101 to the first side road on the east and thence up this side road to the base of the Powell formation (section No. 15, Plate XXII) is considered by the writer as auxiliary to the type section of the Cotter. A study of many other exposures in this area provides information concerning the covered portions of the two sections presented, and proves conclusively that these are not only the most accessible but also the best exposed sections in the district.

The proposed interpretation places the lower boundary below the zone of *Jeffersonia jenneii* and above the last occurrence of the genus *Orospira*. Above this lower boundary the trilobite genus *Goniotelus* first occurs.

The upper boundary is drawn above the bed of spherical chert masses and well above the zone of *Ceratopea jenkinensis* and *C. ankylosa*. The contact, as drawn, is below the very fossiliferous beds of the Powell dolomite known locally as the "Black Ledge," which contains *Goniotelus marionensis* and *Centrotarphyceras yellvillensis*.

Areal Distribution: The Cotter dolomite crops out more widely in Arkansas than any of the other formations here described. It is known to extend north of the Missouri-Arkansas line where it occurs on the higher hills in the southern part of the region indicated on the generalized map. The Cotter, as here restricted, is not known in the northern part of the area but is widely distributed in the southeastern portion of Missouri. This latter region has not been included in the present study.

Thickness: In the vicinity of Cotter, the formation has a thickness of 340 feet. To the north this thickness is less because of the unconformity with the overlying Powell dolomite. In the vicinity of Jenkins Branch, section 7, T. 19 N., R. 15 W., in the Yellville quadrangle, the upper 80 feet of the formation is missing, hence the banded chert in the base of the Powell lies only 20 feet above the bed of spherical chert masses of the upper Cotter. To the north in the same quadrangle at Bull Shoals Mountain, in sections 19, 20, 29 and 30, T. 20 N., R. 15 E., and at Pine Mountain in section 4, T. 20 N., R. 16 W., the Cotter appears to be even thinner. At Long Mountain in section 25, T. 21 N., R. 15 W., the formation appears to be only slightly thinner than in the type locality. North-

DISCUSION OF PLATE IX

Figure 1. The Crooked Creek chert bed of the lower Cotter dolomite, just above the north approach to the bridge at Crooked Creek on Arkansas State Highway 101, two and one-half miles southwest of Cotter, Arkansas.

Figure 2. Massive, bowl shaped chert mass characteristic of the upper Cotter, photographed in the creek bed just south of Sedalia, Benton County, Arkansas.

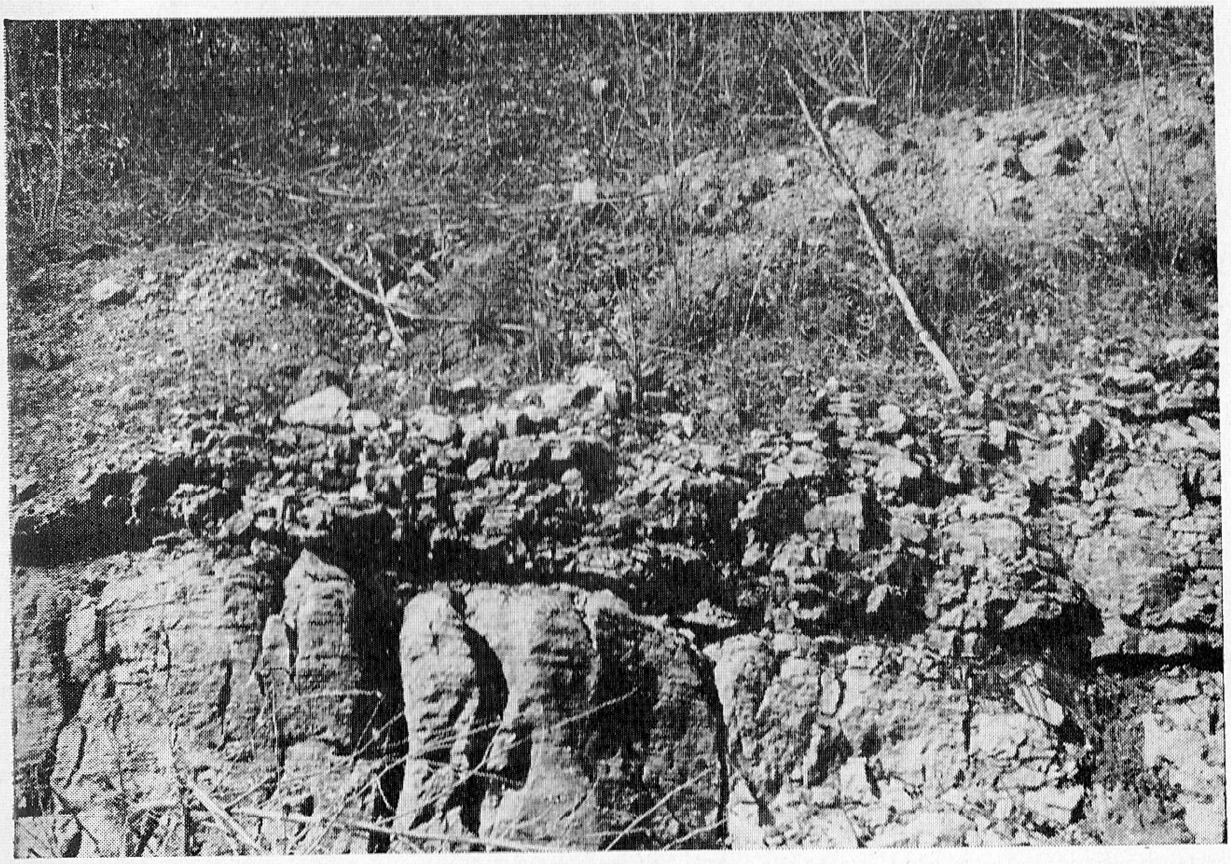

Fig. 1

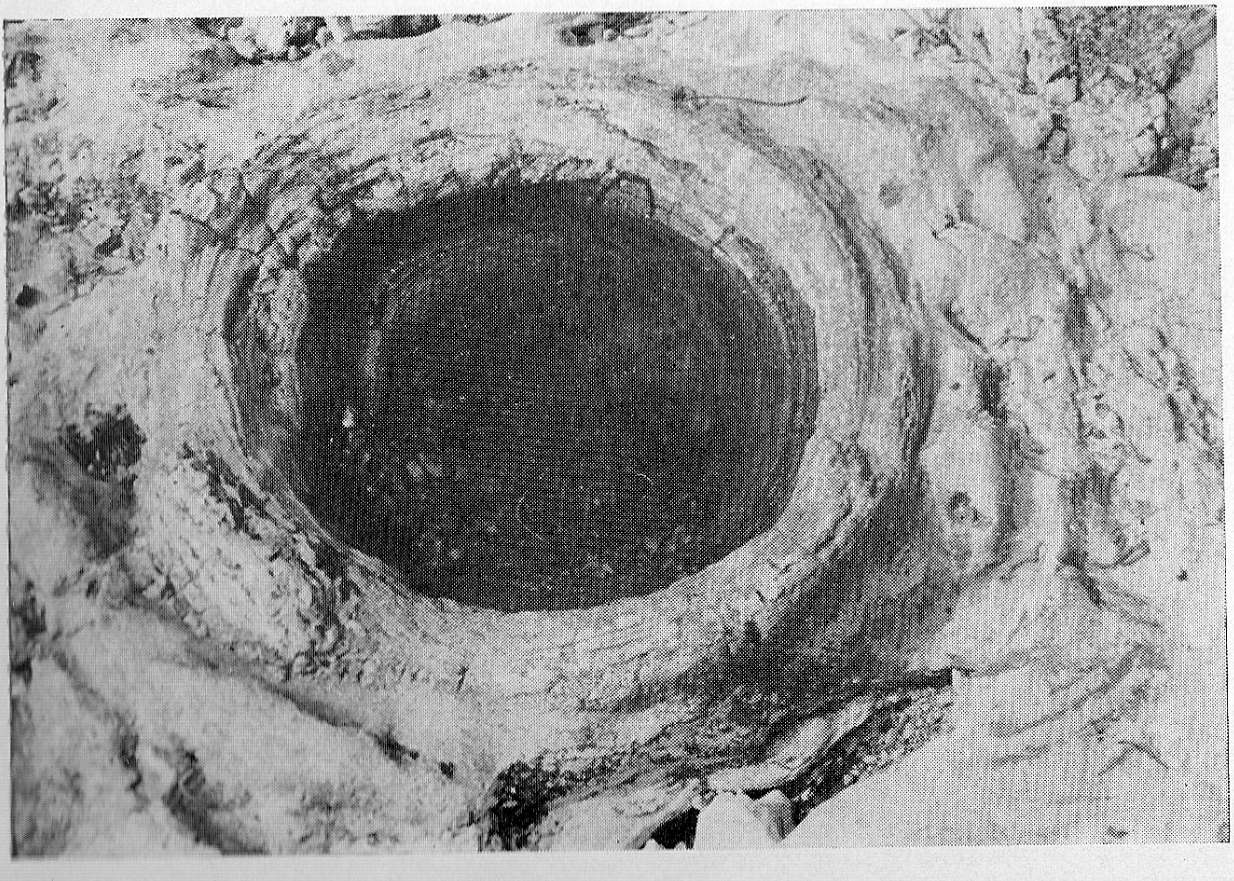

Fig. 2

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ward in Missouri, the Cotter as here described gradually becomes thinner and is overlapped by beds of lower Mississippian age. No Cotter as now defined is known to outcrop in the northern three-fourths of the area included on the map. There is little question but that the formation is present in a portion of the outcrop area of lower Ordovician rocks along the east side of the Ozark Dome, but no information as to its thickness is available.

Lithologic Character: The Cotter is predominantly very cherty dolomite, varying in color from gray to buff, in texture from very fine grained to coarse grained, and from thin to massive-bedded. The chert in the formation is predominantly darker than that of the other formations. In the type area, the dolomite beds in the upper part become very argillaceous locally. Sandstone lenses in the formation are not numerous but when present are variable in thickness over short distances. There are some beds in the formation which, because of their peculiar lithologic character, are helpful in mapping. This is especially true if the associated fauna is also considered.

. Near the base of the formation there is an appreciable thickness of massively bedded, gray, coarsely crystalline dolomite which contains a high percentage of disseminated silica. These beds form the steep bluffs just above the White River flood plain at the type locality. They contain the typical lower Cotter fauna.

Well above these beds the next significant lithologic unit is a layer of interbedded chert and dolomite. It is composed of about equal parts of chert and dolomite. The latter is not distinctive but the chert is very conspicuous. It is very dark bluish-gray, almost black in color, and occurs as three distinct layers. The texture is dense and the few openings it contains are lined with a druse of colorless quartz. This layer has been traced extensively in the Yellville quadrangle. Where it outcrops on the high flats, however, its weathered residue can rarely be differentiated from other weathered cherts. For reference purposes the writer calls this layer "Crooked Creek chert" from the exposures illustrated in section No. 15, Plate XXII, (See figure 1, Plate IX).

Another bed which can be readily recognized on only partially weathered exposures is the Jenkins Branch chert bed. This chert forms an encrustation as the crystalline dolomite weathers. It is very similar to the "Black Ledge" in the Powell dolomite, and can be differentiated only by its fossil content. This chert is reddish-brown to brown in color. Its texture is very open and porous and probably not more than 40 per cent of the mass is chert. The remainder is void if the blocks have been at the surface for a long time. If they have been only recently exposed, as in the road cut just south of Jenkins Branch in the N. E. corner of the S. W. ¼, N. E. ¼, sec. 7, T. 19 N., R. 15 W., the voids are filled with red clay. Commonly some cavity walls are covered with a very thin, finely crystalline quartz druse. These beds contain *Ceratopea jenkinensis* and *C. ankylosa*, and also numerous, poorly preserved, large, low spired gastropods.

The next overlying layers of rock in the Cotter, which are readily recognizable, are those which contain an abundance of chert masses. These are of two common types, spherical masses and "doughnut shaped" masses. They are composed of fairly thick, alternating layers of gray or bluish-grey and white chert. These are easily recognized, not only on the fresh exposures but also in the residuum, and have been identified as far west as Sedalia in Benton County, Arkansas, and Noel in McDonald County, Missouri. Their presence is obvious throughout the vicinity of Cotter, Long Mountain, and Flippin in the Yellville quadrangle. Plates IX and X show excellent examples of each.

DISCUSSION OF PLATE X

Figure 1. A collection of spherical chert masses from the upper part of the Cotter, one and one-half mile north of Flippin, in the S. E. ¼ of section 7, Township 19 N., Range 15 W., Marion County, Yellville quadrangle, Arkansas.

Figure 2. A detailed view of a weathered chert mass from the same locality as figure 1. X. 5.

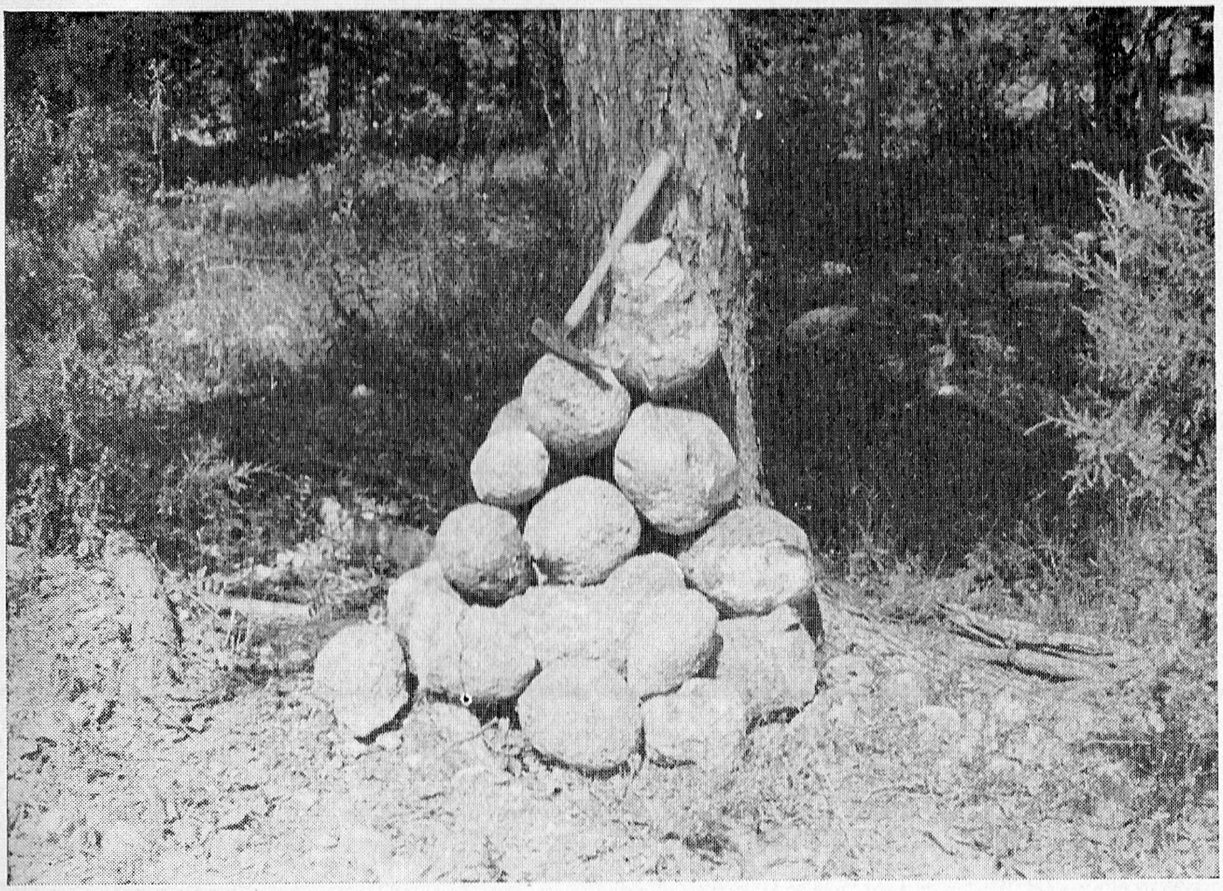

Fig. 1

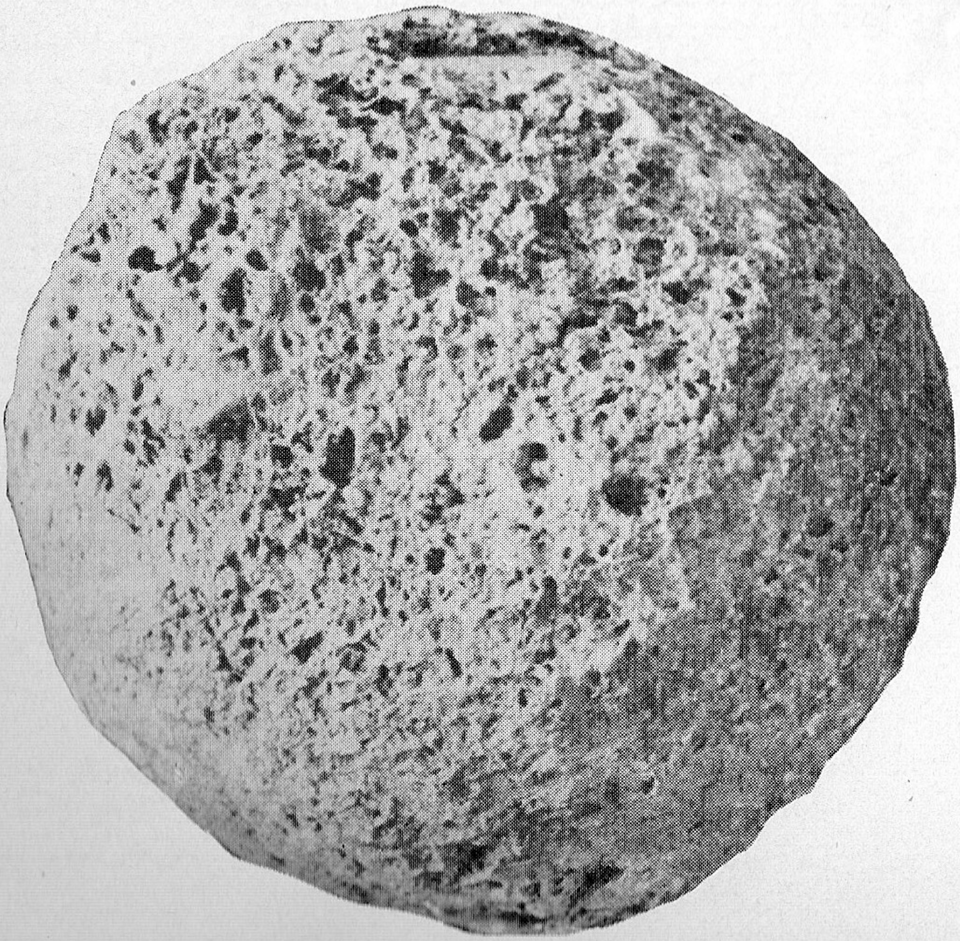

Fig. 2

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Above this chert zone the Cotter formation is more argillaceous. There are some chert free, crystalline dolomite beds and some olive drab shale beds in the upper portion of the formation at the location of section No. 15, Plate XXII. The same sequence prevails near Tracy Ferry over North Fork southeast of Mountain Home in Baxter County, Arkansas. Locally interbedded with the shales and argillaceous dolomite, only a few feet below the base of the Powell, there is a thin chert breccia, mentioned by McKnight (1935) as the possible true contact between the formations. The writer agrees with McKnight in his use of the more recognizable and persistent chert nodules as the mapable boundary.

Sandstone and Shale: Sandstone is a relatively inconspicuous component of the Cotter at the type locality. At the type section a very massive lens is present. In the exposed section it has a thickness of eight feet (See figure 1, Plate XI). This lens thins and disappears laterally within a distance of 200 yards along the outcrop. The shales of the Cotter dolomite are most prevalent in the upper 100 feet of the formation. They are brownish-gray to olive in color, thinly laminated and dolomitic. They resemble very closely the shales of the Powell and can be differentiated only by their stratigraphic position as related to known horizons.

Weathering: The Cotter dolomite weathers very much like the dolomites already discussed. It forms glades and balds. Where the residuum is thin, it supports an abundant growth of *Juniperus virginiana*. The clays that result from the weathering of the dolomite are burnt-orange to brownish-red in color. The chert breaks into angular fragments. To the non-critical observer, there is very little difference between the weathering of the Cotter and the Theodosia and Rich Fountain formations.

The coarse grained, crystalline beds tend to form craggy ledges and cliffs. The argillaceous dolomites and dolomitic shale beds form the more gentle slopes. The sandstone lenses and chert beds cause local steepening of the surface slopes. Considered broadly, the topographic expression in this general area is due more to the elevation of the beds and their relation to the erosion surfaces than it is to any inherent lithologic character.

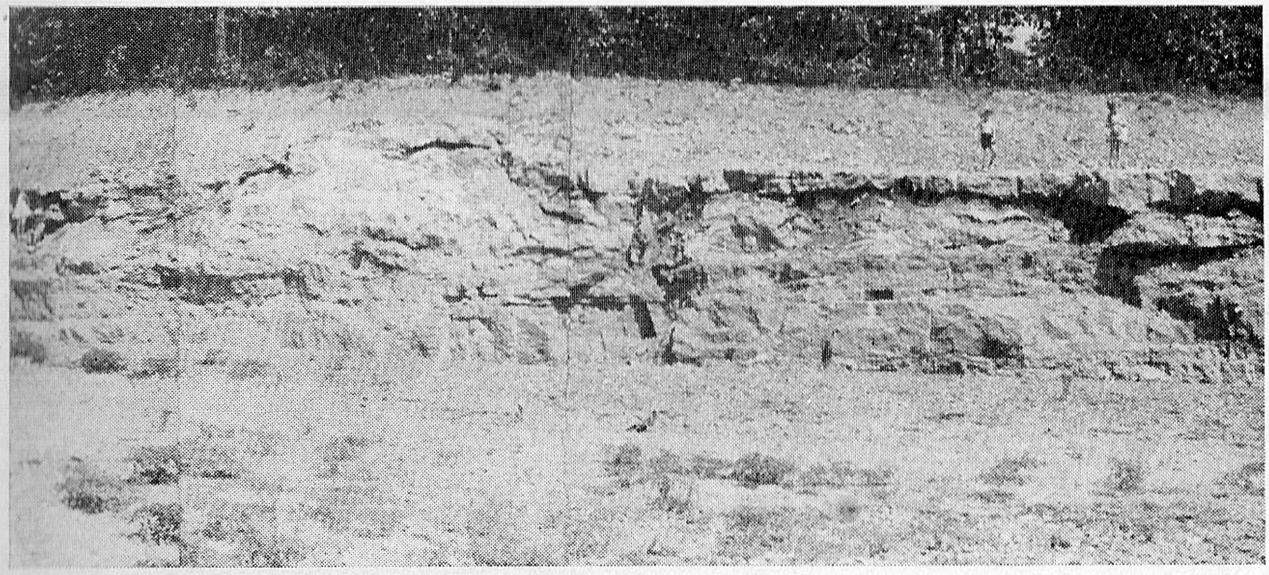
Stratigraphic Relations: The Cotter lies unconformably on the underlying Theodosia. The very irregularly bedded and cross-laminated sandstone which lies at the base is locally conglomeratic. The hiatus between these two formations was relatively short and the interruption in sedimentation was slight. There is no evidence of an angular relationship at the base. Within the area studied there is no suggestion that the two formations are other than parallel. Study of these two formations along the outcrops in eastern Missouri and northeastern Arkansas may shed further light on this relationship. On the strength of brief reconnaissance in Jefferson and Ste. Genevieve Counties, Missouri, the writer is of the opinion that there is thinning of the upper Theodosia in those areas.

The overlying Powell formation lies on the very slightly warped and eroded surface of the Cotter. In the type area, the interval between the beds containing the spherical chert masses and the base of the Powell is 90 feet. In the vicinity of Jenkins Branch this interval is twenty feet or less. On Long Mountain it is slightly less than 20 feet. The relationship is not obviously angular within the confines of a single outcrop, but over a distance of a few miles the evidence of post-Cotter pre-Powell warping becomes conspicuous.

Paleontology: The Cotter fauna of the type locality as known at present comes from two zones. The *Jeffersonia jennii* zone near the base and the

DISCUSSION OF PLATE XI

Figure 1. A composite view of the sandstone lens in the type section of the Cotter, one-fourth mile west of the highway bridge over White River. Note the rapid thinning both to the right and left of the thick sandstone lens. The bed below the children's feet is a massive bluish-gray chert. The base of this bed is not believed to mark an unconformity but rather a plane along which there has been appreciable solution.



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Ceratopea jenkinensis zone near the top. Associated with *J. jennii* are: *Bolbocephalus st. clairi,* which is also present in the Powell dolomite, *Goniotelus semicircularis, Campbelloceras simplex, Cotteroceras ovatus, Cyptendoceras magnus* and *Ophileta sculpta.* Fragmentary specimens of the genus *Piloceras* and of a probable new genus of gastropods have also been found in this zone.

In the upper zone *Ceratopea jenkinensis* of the "Jenkins Branch chert" beds is associated with *Ceratopea ankylosa* and many poorly preserved fragments of both high and low spired gastropods. These latter are too poorly preserved for generic identification.

Age and Correlation: The Cotter fauna has equivalents in the upper "Knox dolomite" fauna of the Appalachian Valley, and in the Shakopee fauna as described by Stauffer (1937) from Stillwater, Minnesota. It has been recently correlated by Ulrich (1938, Pl. 58), with the upper part of the Arbuckle limestone of Oklahoma and with a portion of the Beekmantown of New York.

POWELL FORMATION

History: The name Powell was coined by Ulrich (1915) as a name for those beds which previously had been included in his restricted Yellville formation. The name was derived from Powell Station, now abandoned, on the Missouri-Pacific Railroad about two miles down Crooked Creek from the present village of Pyatt in Marion County, Arkansas. It was first described as a unit by Purdue and Miser (1916) in the Eureka Springs-Harrison Folio. The lower boundary which they used is an irregularly bedded sandstone and conglomerate. The upper contact with the Everton is present at the type locality but the lower is not. The lower boundary crops out four miles east of here in the vicinity of Georges Creek. Between these two points the writer discovered some folding and possibly faulting, which made it difficult accurately to measure the section. Ulrich, during studies made with Dake and Bridge and with McKnight, pointed out a thin conglomeratic chert, cropping out just west of Yellville, as the base of the formation. McKnight (1935) in later work accepted the formation essentially as it was delineated by Ulrich except that he drew the base at the delicately banded chert nodule bed which is very persistent and more readily recognized than the locally occurring chert breccia which lies only a few feet below. The writer believes that McKnight's (1935) lower boundary is the more acceptable of the two because it is better for mapping purposes. No faunal remains have yet been found in the intervening beds at any locality.

Scope of the Formation: The formation includes all of those dolomite beds lying between the delicately banded chert nodules, which will here be called Bull Shoals Mountain chert, and the basal conglomerate of the overlying Everton formation. The unconformable relationship of the Powell with the overlying formation eliminates any possibility of establishing a true upper boundary in this area. This can be accomplished only in northeastern Arkansas within the boundaries of Lawrence and Sharp Counties, where the overlying Smithville limestone of current usage is said to be present. Considering these facts, it is apparent that all of the discussion of the formation included in this report pertains to a lower portion of the formation. Time and funds have not been available for detailed work in the Smithville area.

The base of the Powell is drawn below an abundantly fossiliferous and siliceous bed, locally known as the "Black Ledge." No fossils have been collected

DISCUSSION OF PLATE XII

Figure 1. The "Black Ledge" chert and dolomite out-cropping along the county road in the N. E. ¼, N. W. ¼, T. 19 N., R. 16 W., along Fallen Ash Creek in Marion County, Yellville quadrangle, Arkansas.

Figure 2. The Bull Shoals Mountain chert bed above the base of the Powell dolomite as it appears on the outcrop on the road over Bull Shoals Mountain, in the S. E. ¼, sec. 19, T. 20 N., R. 15 W., Marion County, Yellville quadrangle, Arkansas.

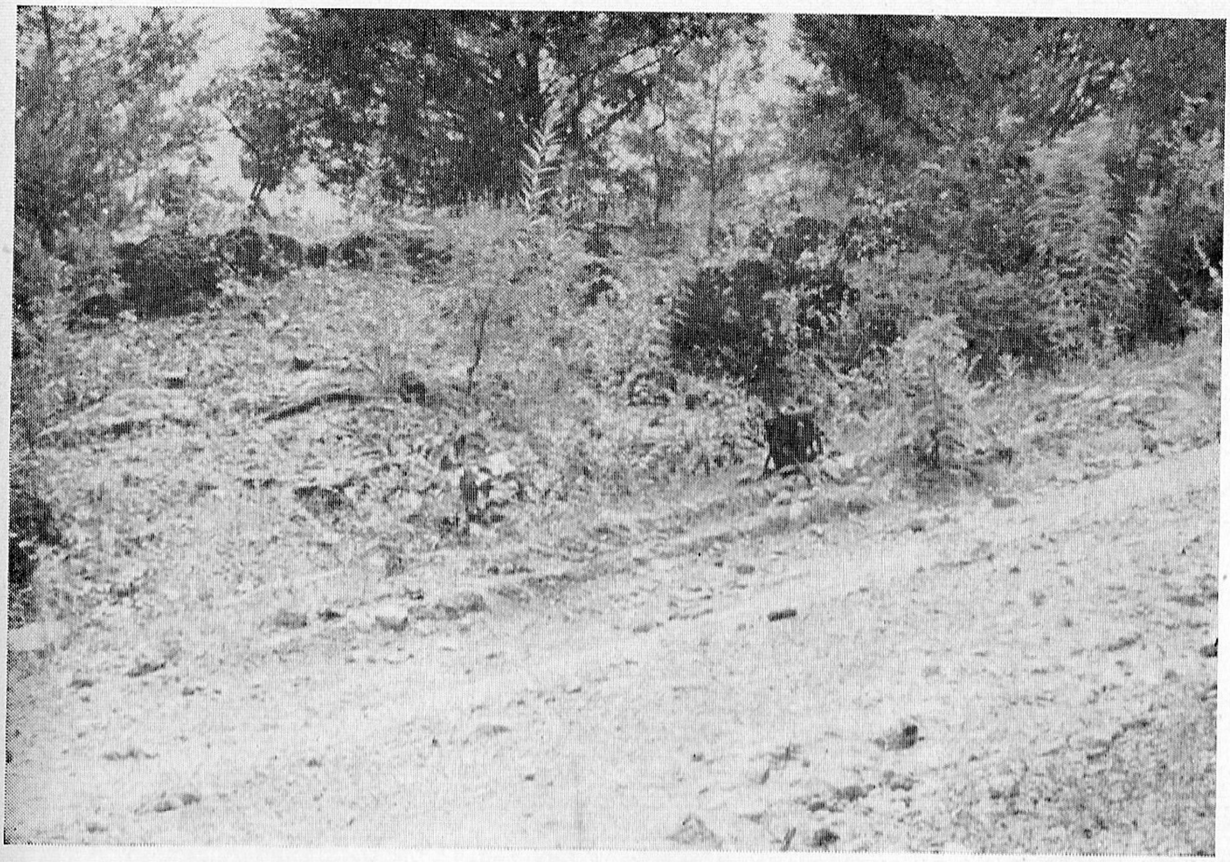

Fig. 1

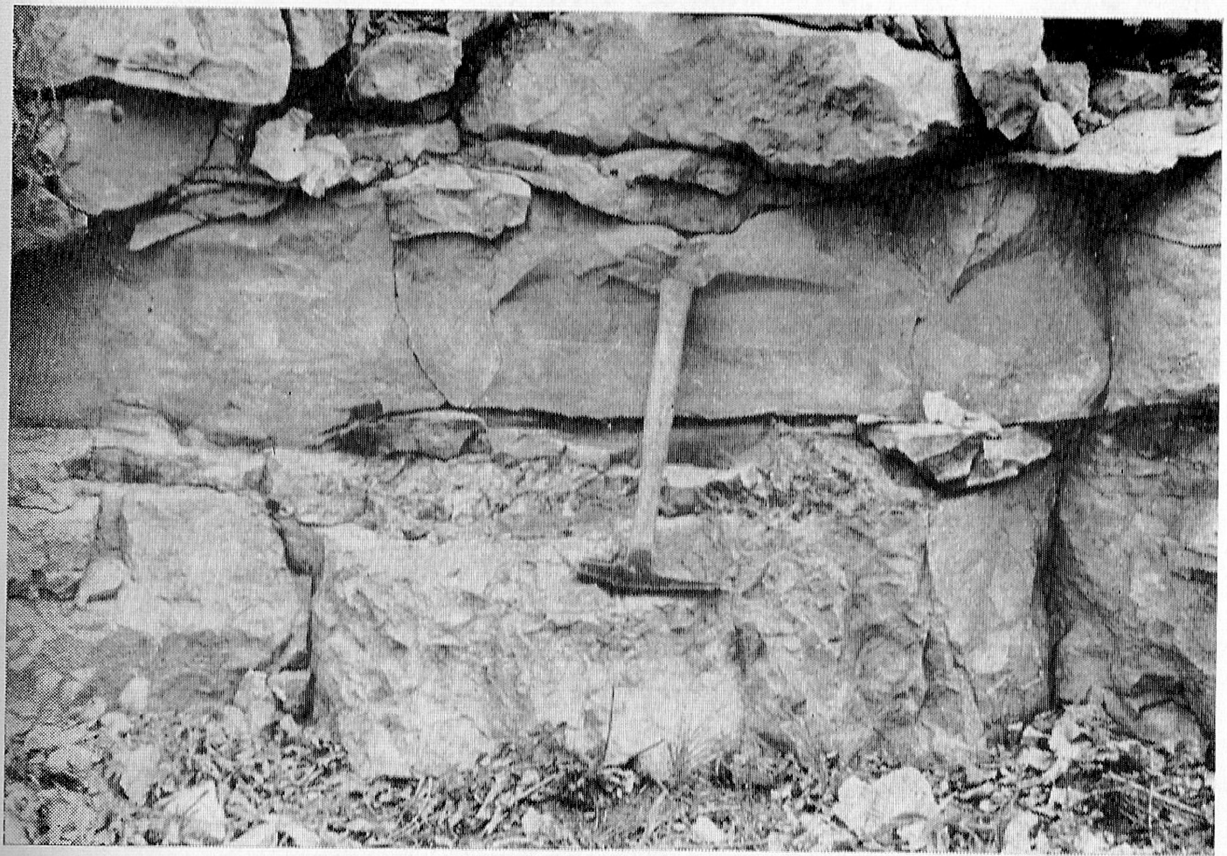

Fig. 2

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from the beds between the "Black Ledge" and the base. In the area under consideration fossils have been collected from float above the "Black Ledge," but the writer has not been able definitely to associate the chert in which they were found with any portion of the section and therefore, is reluctant to make any assertions.

Areal Distribution: The Powell dolomite is essentially restricted to the Arkansas section of the area under consideration. There is a possibility that the lowest portion may cover the highest hills just north of the state line in Ozark County where Missouri Highway 5 crosses the boundary. The Powell formation is known in Bollinger and Cape Girardeau Counties, Missouri, and probably extends up into Perry County. Its presence in Ste. Genevieve County, reported by Weller and St. Clair (1928), is corroborated by Ulrich in their report. Whether this is the Powell dolomite as defined by McKnight (1935) and by the writer is a matter of conjecture until more complete faunal collections are made in the area. A number of species reported from the Powell in Ste. Genevieve County have been found in the lower Cotter as now described. This is also true of beds referred to as Powell in Jefferson County.

Thickness: The maximum thickness of the Powell known in the area has been cored at the site of the North Fork Dam, now under construction for the U. S. Engineering Department, on the North Fork of White River a few miles above where it joins White River at the town of Norfork in Baxter County. The log of these holes, section No. 17, Plate XXIII of this report, shows a thickness of 214 feet. An incomplete section, measured in the bluff of Crooked Creek on U. S. Highway 62 about one and three-fourths miles northwest of Yellville in the S. E. ¼, sec. 31, and in the S. W. ¼, sec. 32, T. 14 N., R. 16 W., contains 174 feet. From these points the formation thins to the north. At Pine Mountain sec. 4, T. 20 N., R. 16 W., in the Yellville quadrangle, and to the west of this point McKnight (1935) has mapped about 100 feet of the formation. The thinning is due to post-Powell pre-Everton erosion. The thickness in areas to the east and west cannot be estimated until further studies are made in the light of the present definition of the formation.

The thinning of the beds to the north is quite rapid. To date, on top of the highest hills north of the Missouri-Arkansas line in the area indicated on the generalized map, no outcrops of rocks which are definitely of Powell age have been observed. Therefore, if any Powell is present, it is only a thin representation of the very lower portion of the formation which, with the exception of the basal chert, very closely resembles the lithology of the upper Cotter.

In eastern Missouri the thickness of 200 feet for the formation as reported by Weller and St. Clair (1928) in Ste. Genevieve County must be accepted with reservation until their boundaries are re-examined in the light of the present definition.

Lithologic Character: The Powell formation is composed predominantly of dolomite, argillaceous dolomite, dolomitic shale and shale. Sandstone occurs only as very thin and locally restricted lentils that are of no significance in correlation. Chert is present at a few points in the exposed section, but only that at the base and the chert formed by the weathering of the "Black Ledge" are of importance in correlation.

The dolomite is predominantly of the type which has been called "cotton rock" in this report. This is a very fine grained, light gray to white or buff

DISCUSSION OF PLATE XIII

Figures 1 and 2. Illustration of the finely banded Bull Shoals Mountain Chert of basal Powell age, photographed under glass and glycerine. Figure 1 shows the customary banding to be expected, and figure 2 shows not only the customary banding but also a secondary set of bands. Scale of both pictures X 1.

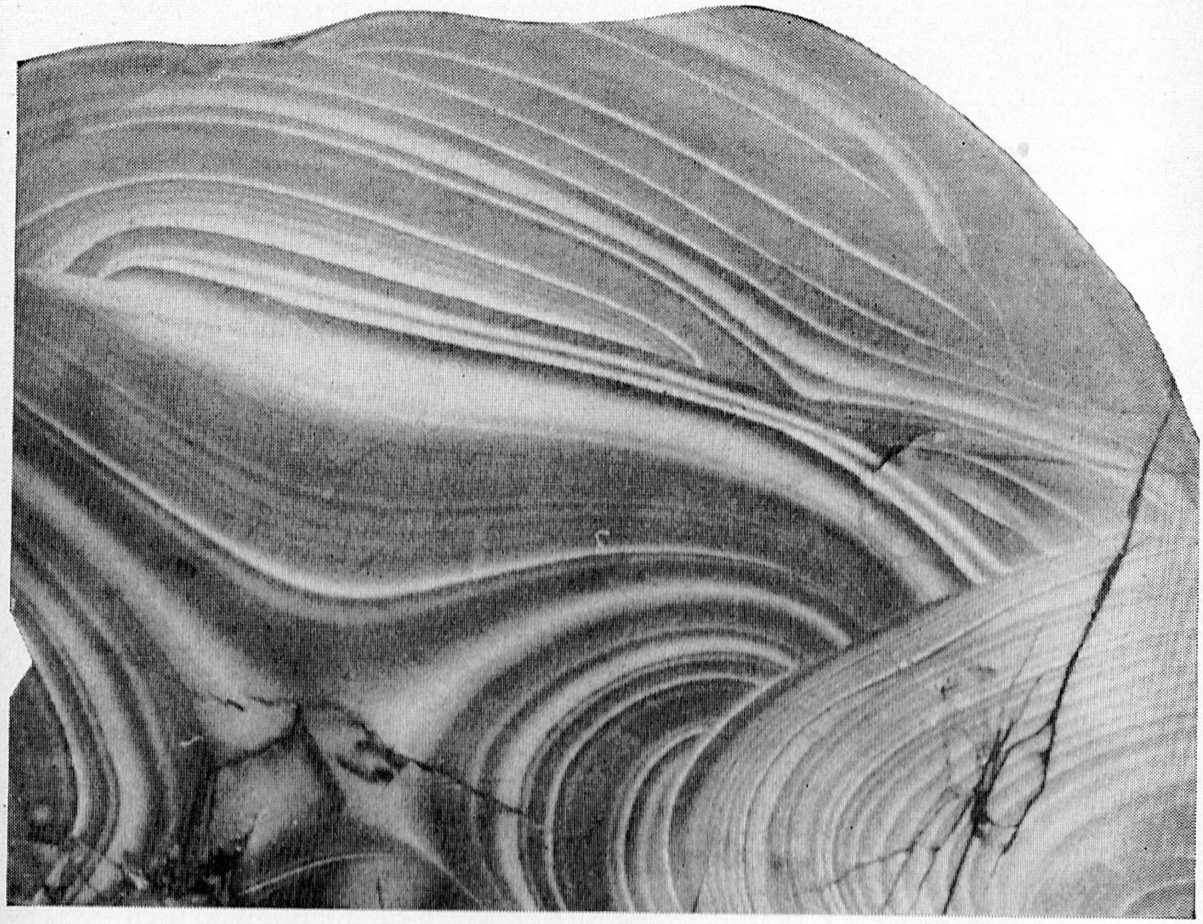

Fig. 1

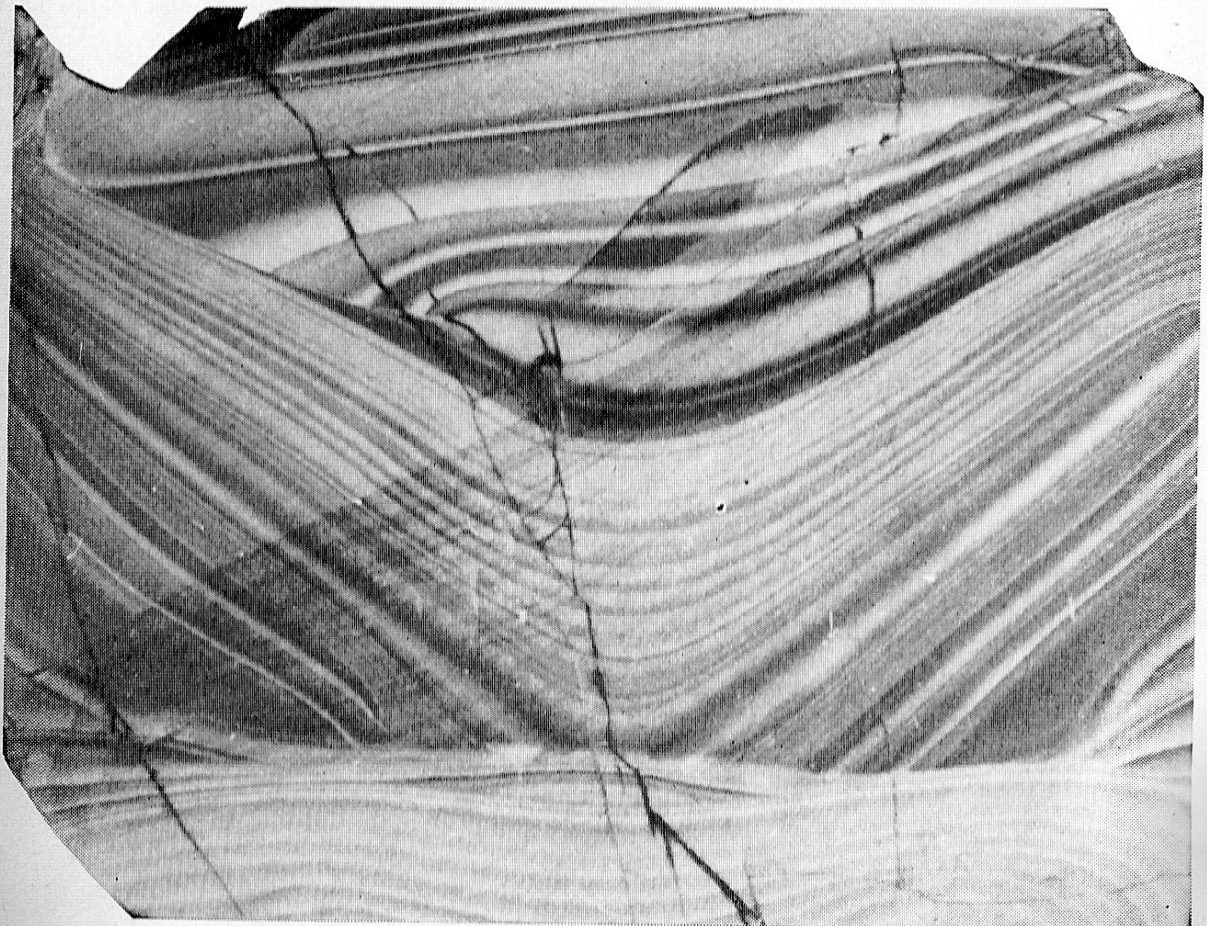

Fig. 2

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argillaceous dolomite which in this formation occurs in beds varying from a few inches up to three feet in thickness. These dolomite beds usually weather to a smooth surface or, if they are decidedly argillaceous, break down into small, thin, angular pieces. Some of the dolomite is crystalline. A finely crystalline variety, occurring in beds up to two feet in thickness, is commonly light gray to cream in color. It weathers to a smooth white surface and forms low ledges on weathered slopes.

A number of coarsely crystalline dolomite beds are also known in the formation. Of these, one is of especial significance. It is referred to as the "Black Ledge" in the zinc mining region in north central Arkansas. This reference is doubtlessly an allusion to the very dark color of the bed when weathered. This bed is one of the most important stratigraphic markers in the entire section. It is siliceous and weathered exposures are very rough porous masses of chert covered over and filled with druses of crystalline quartz. Other coarsely crystalline dolomite beds tend to weather in this fashion, but are not known to develop the massiveness of this bed. Differentiation between the "Black Ledge" and the others is easy because the former is usually abundantly fossiliferous.

Shale is a rather important constituent of the formation. Near the base the shale beds are dolomitic, slightly arenaceous and bluish-gray on freshly exposed outcrops. Weathering causes a color change to a greenish-brownish-gray. In these lower shales in the vicinity of Yellville McKnight (1935) has reported the presence of salt hoppers. Desiccation cracks are common in the shale beds and also in the "cotton rock" layers associated with them.

Another shale bed of significance lies about 20 feet below the "Black Ledge." Cores from the Norfork Dam area show it as dark gray dolomitic shale approximately 10 feet thick. This shale bed appears to be as widely distributed as the "Black Ledge." The presence of the two in any exposed section appreciably facilitates correlation by lithologic character. Weathering of the dolomitic shale layer produces shale very similar to that occurring near the base of the formation.

The chert in the Powell formation is sparse in quantity when compared with the amount in the underlying Cotter formation. It occurs as thin layers, small nodules, and in the "Black Ledge," as hackly irregular masses. The color is, as a rule, lighter than that of the Cotter and the banding, if any, is more imperfect, excepting, of course the very finely banded chert at the base of the formation. No oölitic chert has been found.

The chert nodules at the base of the formation are distinctive because of their very fine and delicate banding as shown in Plate XIII. This nodular chert is referred to as the Bull Shoals Mountain chert. The banding, as portrayed in figure 1, appears to be parallel to the surface of the nodule in which it is found. In figure 2, banding similar to that of figure 1 may be noted, but another set of bands is also present. The latter are relatively faint and very definitely intersect the heavier bands which also mutually intersect.

Another noteworthy lithologic feature of the Powell formation is the rather high content of silica of both the crystalline and "cotton rock" types of dolomite. This is not obvious on freshly exposed outcrops, but weathered outcrops show it conspicuously as joint fillings and as quartz druses. These small masses of druse are a common feature of the residuum, but the writer does not believe

DISCUSSION OF PLATE XIV

Figure 1. Residual "Black Ledge" chert along Fallen Ash Creek, three miles north by northeast of Yellville, Marion County, Yellville quadrangle, Arkansas.

Figure 2. A view showing the angular relationship between the upper Ordovician (Powell?) and the Sylamore sandstone as it appears approximately two miles northwest of Eureka Springs on U. S. Highway 62, Eureka Springs quadrangle, Carroll County, Arkansas.

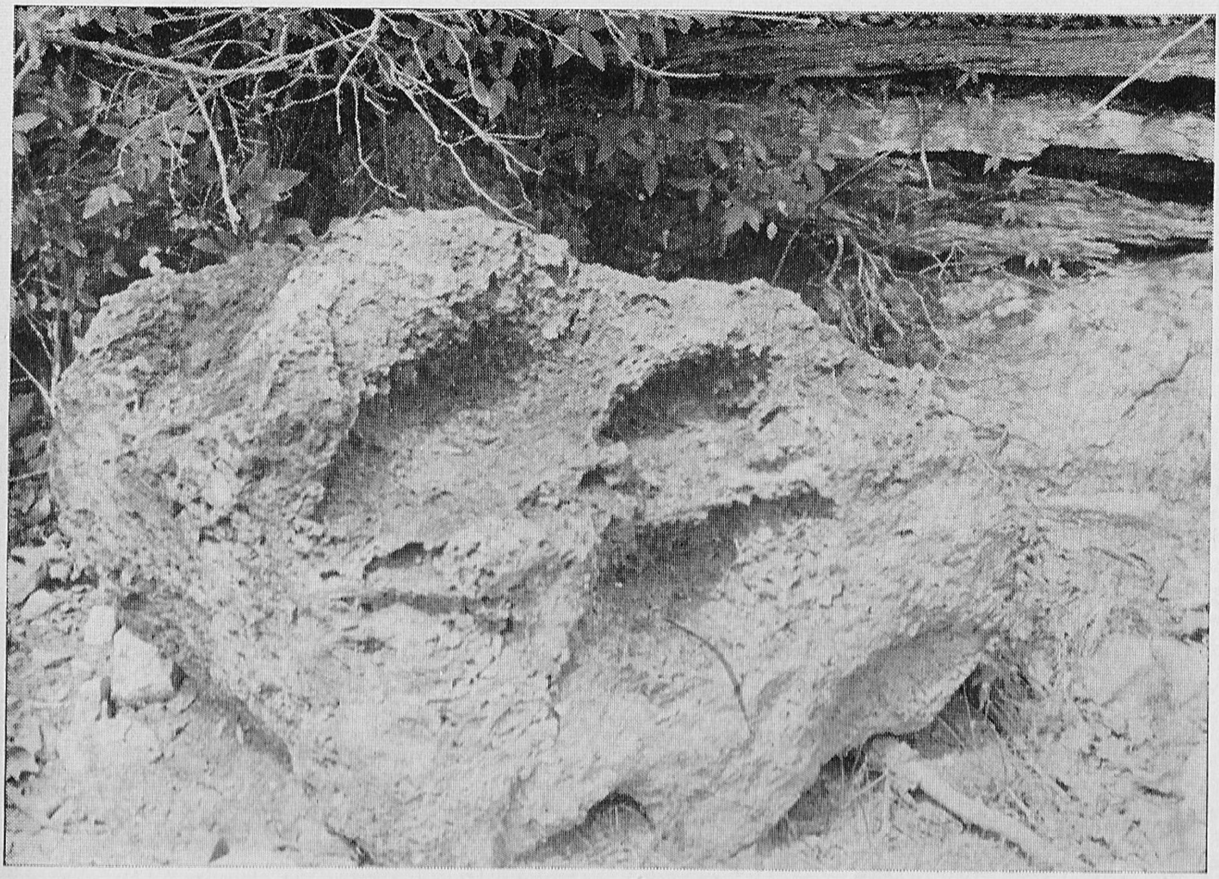

Fig. 1

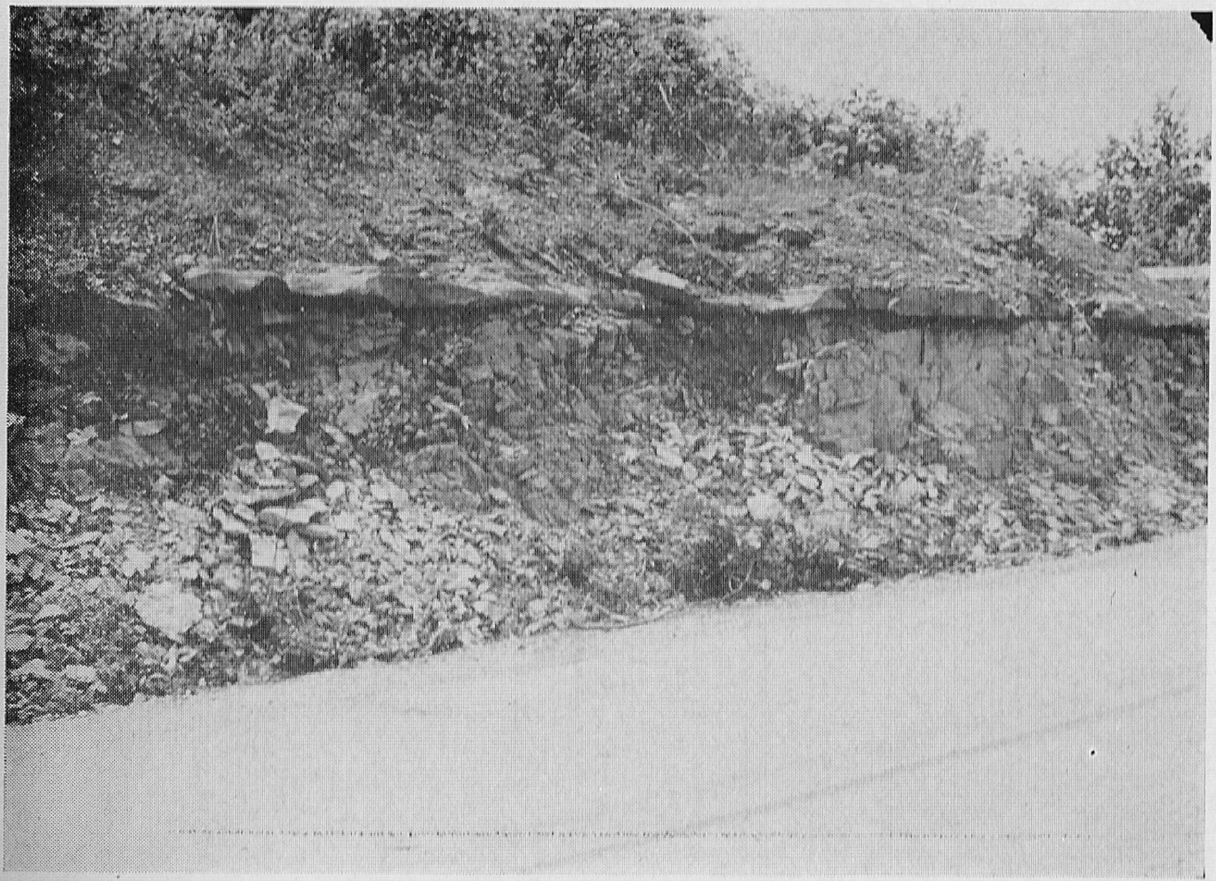

Fig. 2

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that they are characteristic of, and are only to be found in, Powell strata. At many localities the other formations described here also have druse in the residuum but not in such great abundance.

The residuum of the "Black Ledge" is worthy of special consideration because of the importance of this bed in mapping. It consists of very porous, drusy masses of chert, composed of numerous thin plates intersecting at all angles, supported by irregularly rounded or tubular, yellowish-brown, finely-porous chert. Most of the larger openings in the mass are lined with a drusy crystalline quartz. This quartz is normally clear and colorless, but may be somewhat smoky, due probably to a thin superficial layer of iron oxide. A mass of this material is very difficult to work for fossils. If it has been completely silicified, it works very much like ordinary chert and directional breaks can be made, but if it has been only recently exposed a long chisel can be driven completely into a mass of considerable size without causing any fracture. This character allows the mason readily to shape the material into blocks which are much used locally in the construction of rock fences, walls and ornamental stone work in Marion County, Arkansas. Figure 1, Plate XIV, shows a large block of this characteristic "Black Ledge". chert as exposed along the side of the road.

Weathering: Much of the discussion concerning the weathering products of the various specific beds is included above. As a rule, the residual products of the weathering of the Powell are clay, small amounts of granular silica, and some angular chert. On relatively flat surfaces the overburden of clay may become deep, but surfaces of this type are not common features of the topography in this region. The fine clay and silica is usually removed almost as rapidly as it is formed. The surface layer of residuum in areas of Powell outcrop is commonly very thin. Bed rock protrudes generally over the surface. Plants which have a great affinity for lime, therefore, are abundant on slopes underlain by Powell strata. *Juniperus virginiana*, commonly known as cedar in this region, occurs in glades where there is a thin soil, but in those areas where most of the soil has been removed by sheet wash, the surface is barren except for a few scattered weeds and clumps of sedge grass. These areas are called "balds" as in Missouri and have the same appearance as those which are present on the other formations described in this report. Weller and St. Clair's (1928, Pl. 6, Fig. B) reference to a typical outcrop of the Powell formation in Ste. Genevieve County can be duplicated on all of these formations at various localities. The character of the surface, the topographic expression and floral distribution at the surface of the Powell strata depends more directly on the relative elevation of the formation in the region where it is found than on the character and composition of the rock itself.

Stratigraphic Relations: The Powell formation lies with slight angular unconformity on the Cotter strata. This relationship is explained in the discussion of the latter formation. The slightest change in the character of the rocks at the base of the Powell infers a change in conditions of sedimentation but does not demand emergence. The presence of ripple marks indicates only a shallowing of the area of deposition. The presence of desiccation cracks does, however, indicate emergence even though slight. These, with the angular relationship previously mentioned, require an emergence sufficiently long to accomplish some erosion of the underlying Cotter before the Powell sea returned.

The upper contact of the Powell is one of unconformity in this area. Just what relationship it has with the overlying Smithville formation has not as yet been determined by the writer. McQueen (1931, Pl. III), in his columnar section of Ozark formations, indicates an unconformity at this point in the section, although no evidence is offered to substantiate this in the text of the report. Wilmarth (1934) in the Tentative Correlation Charts of Arkansas does not indicate an unconformity at this point in the section. In the Yellville quadrangle the Powell is, as a rule, overlain unconformably by the Everton. To the southeast in Baxter County at the site of the Norfork Dam, the same relationship prevails. West of Elixir Springs in the Yellville quadrangle, McKnight (1935) has mapped the Boone formation, including the white to brown phosphatic sandstone at the base as lying unconformably on the Powell. Near Eureka Springs, Arkansas, in the Eureka Springs-Harrison folio, Purdue and Miser (1916) have mapped the Chattanooga shale with the Sylamore sandstone at the base, as lying directly on the Powell. The fact that the underlying beds here are Powell in age is not substantiated by faunal evidence. To date, the writer has not had an opportunity to examine carefully the beds, shown in figure 2, Plate XIV, which show the relationship, in the light of the present concept of the formation.

Paleontology: The fauna of the Powell, thus far known, has all been collected from the "Black Ledge." The predominant fossils, which are usually poorly preserved internal and external moulds, are *Centrotarphyceras yellvillensis, Bolbocephalus st. clari, Goniotelus marionensis, Diparelasma silicum, Syntrophopsis arkansasensis, S. grandis,* and *Leseurilla magnus.* Most of these are new species.

Age and Correlation: The general aspect of the fauna is like that of the Ft. Cassin beds of Vermont. Based on the general aspect of the brachiopod fauna (according to Ulrich and Cooper, 1938) they appear to be the early species of genera of upper Canadian age which have their affinities in the arctic realm.

SYSTEMATIC ACCOUNT OF THE FAUNAS

Phylum **PORIFERA**
Class **SPONGIAE**
Subclass **SILICISPONGIAE**
Order **LITHISTIDAE**
Suborder **TETRACLADINA**
Family **ARCHAEOSCYPHICAE** Rauff
Genus **OZARKOCOELIA**
Cullison n. gen.

Description: Cylindrical, hollow, branching stems are characteristic of the growth of this genus. The surface is smooth or may bear small, irregularly shaped, transverse prominences. The branching is not dichotomous but may give rise to as many as four stems at a single point. The surface exhibits irregularly distributed pores which are the openings of the oscula. In specimens etched from dolomite, these oscula are rounded tubes which extend directly through the spicular structure of the wall and, in straight sections of the tube, intersect both wall surfaces at right angles. The cloaca is of variable diameter, dependent upon the size of the stem. The wall is of uniform thickness except at the points of branching where it is thickened.

The spicular structure of the genus is composed of three zones besides the exterior surface and the wall of the cloaca. The cloaca wall is penetrated by closely spaced pores, arranged in both transverse tiers and vertical rows. The zone immediately behind this surface is composed of a lattice of spicules. Vertically the spicules are fused into columns which stand between the rows of pores. The tiers of pores are separated by a network of irregularly attached and irregularly arranged spicules. The spicules in the vertical columns branch off the main column and at the outer surface of the sponge they again coalesce so as to form columns which are perpendicular to this surface. The outer zone has a thickness of 4 mm. ±, and the inner zone is approximately the same. The medial zone is the thickest of the three. It is this medial zone that is thickened at points of branching.

Discussion: The genus resembles *Lissocoelia* Bassler (1927) but differs in the following respects: the stems are not entirely smooth and they do not branch dichotomously; the openings of the oscula are not equally distributed over the external surface, and are neither microscopic nor uniform in size.

Genotype: *Ozarkocoelia irregularis.*

OZARKOCOELIA IRREGULARIS

Cullison n. sp.
Plate XXIV, figures 1-8

Description: Sponge body, smooth hollow stems, usually about 30 mm. in diameter although varying from 15 to 55 mm. depending on location in the stem. Branching occurs at irregular intervals, the intervals varying from 1 to 5 cm. A complete growth is not known. Surface commonly smooth but frequently interrupted by low transverse ridges. Surface marked by rounded pores varying from .15 to .35 mm. in diameter, distributed irregularly; distance between pores rarely more than the maximum pore diameter. Spicules coarse, easily observed under a magnification of 5 diameters. Cloaca varies from 5 to 10 mm. in diameter. The ostium appear as transverse tubes directly through the wall. This species is not as abundant as *Archaeoscyphia annulata* and is more restricted in range in the Ozark region.

Types: Holotype Y. P. M. 17136, M. S. M. locality 72.53
Paratype M. S. M. 7215, M. S. M. locality 72.53
Paratype Y. P. M. 17137, M. S. M. locality 58.3
Paratype M. S. M. 7216, M. S. M. locality 58.3

Occurrence: School Mine ledge of the Rich Fountain formation

ARCHAEOSCYPHIA Hinde, 1889
ARCHAEOSCYPHIA ANNULATA
Cullison n. sp.
Plate XXIV, figures 9-12

Description: Sponge body elongate, tubular, expanding rapidly in basal portion to a diameter of 20 mm. and then tapering more slowly. Wall thickness variable, 3 mm. at inter-ring section near base to 25 mm. on ring section near top of holotype. Cloaca broad, 30 mm. in maximum diameter. Inner wall surface a lattice of pores. Pores roughly rhombic in outline, and separated laterally by columns of fused spicules which are as thick as the pores are wide, and longitudinally by individual spicules. Outer wall surface also a lattice of deeply weathered spicules. A few partially preserved exterior surfaces indicate an irregular distribution of pores of various sizes up to .4 mm. in diameter. The exterior surface is marked by strong undulating transverse rings due to the thickening of the wall. Near the base these rings are small, about twice the minimum wall thickness. Near the top they become wider and thicker, up to four times the minimum thickness of the wall at that point. The rings involve a thickening of the spicular lattice which is mentioned above.

Specimens of this species commonly occur as externally ringed, hollow or partially filled cylinders of chert which exhibit a lattice-like surface both inside and out.

Types: Holotype Y. P. M. 17135, M. S. M. 72.42
Paratype U. S. N. M. __, M. S. M. locality A2.1
Paratype M. S. M. 7217, M. S. M. locality 72.42
Paratype M. S. M. 7218, M. S. M. locality 72.42

Occurrence: Rich Fountain formation and possibly in the lower part of the Lutie member of the Theodosia formation.

Phylum **MOLLUSCOIDEA**
Class **BRACHIOPODA**
Order **NEOTREMATA** Beecher
Suborder **ORTHOIDEA** Schuchert and Cooper (1932)
Superfamily **ORTHACEA** Walcott and Schuchert (1908)
Family **FINKELNBURGIIDAE** Schuchert and Cooper (1932)
Genus **DIPARELASMA** Ulrich and Cooper (1936)
DIPARELASMA SILICUM Ulrich and Cooper (1938)
Plate XXV, figures 1-3

Description: Shells small, wider than long, with strongly convex lateral and anterior margins. Surface marked by moderately strong but unequal costellae of which there are four or five in 1 mm. at the anterior margin.

Remarks: The figured specimens were obtained from Ulrich's locality three miles north by northeast of Yellville, Arkansas, where they were present in porous residual chert.

Figured specimens:

Y. P. M. 17130, M. S. M. locality A4.8
M. S. M. 7226, M. S. M. locality A4.8
M. S. M. 7227, M. S. M. locality A4.9

Occurrence: "Black Ledge" of the Powell dolomite.

Suborder **CLITAMBONOIDEA** Öpik (1934)
Superfamily **CLINTAMBONACEA** Schuchert (1929)
Family **TRITOECHIIDAE** Ulrich and Cooper (1936)
Subfamily **TRITOECHIINAE** Ulrich and Cooper (1936)
Genus **TRITOECHIA** Ulrich and Cooper (1936)
TRITOECHIA TYPICA Ulrich and Cooper (1938)

Plate XXV, figures 7-8

Discussion: These figured specimens closely resemble *T. typica* in all respects. The larger dorsal valve has a width of 19 mm. and a length of 11 mm. These dimensions are comparable to *T. typica* and the swollen and discontinuous costellae of the dorsal valve is a characteristic of this species. However, these specimens do not show that the costellae are hollow anteriorly, which may be due to mode of preservation.

Figured specimens:

M. S. M. 7230, M. S. M. locality 105.18
Y. P. M. 17183, M. S. M. locality 105.16
M. S. M. 7231, M. S. M. locality 105.16
Y. P. M. 17184, M. S. M. locality 105.16

Occurrence: Middle Theodosia formation, lower part of the Blackjack Knob member.

TRITOECHIA cf. DELICATULA
Ulrich and Cooper (1938)

Plate XXV, figures 4-6

Discussion: These figured specimens most closely resemble the description and the figures of this species published by Ulrich and Cooper. They differ from *T. typica* by having much finer and fewer swollen costellae on the surface.

Figured specimens:

M. S. M. 7228, M. S. M. locality 105.16
M. S. M. 7229, M. S. M. locality 105.16

Occurrence: Lower Blackjack Knob member of Theodosia formation.

Subfamily **POLYTOECHIINAE** Öpik (1934)
Genus **POLYTOECHEA** Hall and Clarke (1892)
POLYTOECHEA INAEQUISTRIATA Ulrich and Cooper (1938)

Plate XXV, figures 12-15

Discussion: The figured specimens of this species represent the most common brachiopod, other than *Diparelasma silicum*, found in the Powell dolomite. This species is characterized by the high cardinal area, erect beak of the ventral valve and the unequal size of the costellae which are present on both valves.

Figured specimens:
M. S. M. 7232, M. S. M. locality A5.6
Y. P. M. 17131, M. S. M. locality A5.6

Occurrence: "Black Ledge" of the Powell dolomite.

Suborder **SYNTROPHIOIDEA** Ulrich and Cooper (1936)
Family **SYNTROPHOPSIDAE** Ulrich and Cooper (1936)
Genus **SYNTROPHOPSIS** Ulrich and Cooper (1936)

SYNTROPHOPSIS ARKANSASENSIS Ulrich and Cooper (1938)

Plate XXV, figures 9-11

Description: Shell small, a little wider than long, hinge narrow; lateral margins narrowly rounded; surface marked by a few strong growth varices. Ventral valve inflated with shallow sulcus. Dorsal valve bears a prominent fold. For internal characteristics see Ulrich and Cooper (1938).

Figured specimen: M. S. M. 7259, M. S. M. locality A4.10.

Occurrence: "Black Ledge" of the Powell dolomite.

SYNTROPHOPSIS GRANDIS

Cullison n. sp.

Plate XXV, figures 16-19

Description: Ventral valve nearly as long as wide; hinge-line straight, a little more than one-half of the width of the shell; cardinal extremities broadly rounded; beak pointed; inter-area almost orthocline; sulcus deep at the front and disappearing about one-third the distance from the beak. Dorsal valve strongly arched; surface marked by concentric growth lines.

Remarks: This species is represented by three internal moulds of ventral valves and one fragmentary external mould of the dorsal valve.

Types: Holotype Y. P. M. 17132, M. S. M. locality A5.6
Paratype: Y. P. M. 17133, M. S. M. locality A5.6
Paratype: M. S. M. 7233, M. S. M. locality A5.6

Occurrence: "Black Ledge" of the Powell dolomite.

Phylum **MOLLUSCA**
Class **GASTROPODA**
Subclass **STREPTONEURA**
Order **ASPIDOBRANCHIA**
Suborder **DOCOGLOSSA**
Superfamily **TRIBLIDIACEA**
Family **TRIBLIDIIAE**
Subfamily **TRIBLIDIINAE**
Genus **PROPLINA** (M. S. Ulrich and Bridge) Kobayoshi (1933)
PROPLINA ELONGATA

Cullison n. sp.

Plate XXV, figures 20-23

Description: Subconical or patelliform gastropods with apex directed toward and extending well beyond the margin of the narrower end, here arbitrarily designated as anterior. Aperture elongate, oval, broadly rounded posteriorly, narrowly rounded anteriorly, laterally compressed seemingly with thin margins. Ratio of length to width in holotype and paratype 1.375 and 1.369 respectively.

Apex relatively large, medium pointed, strongly curved dorso-ventrally to form a hook anterior to base. Ornamentation consists of a few transverse rugae. Shell structure and muscle scars unknown.

Remarks: The holotype and paratype are internal moulds preserved in gray chert. External moulds are unknown.

Types: Holotype M. S. M. 7263, M. S. M. locality 72.51
Paratype Y. P. M. 17134, M. S. M. locality 57.1

Occurrence: Lower Rich Fountain formation.

PROPLINA GRANDIS

Cullison n. sp.
Plate XXV, figures 24-25

Description: Subconical or patelliform gastropods with apex directed toward and extending only very slightly beyond the margin here arbitrarily designated as anterior. Aperture slightly elongate, broadly oval, length 40 mm., width 32 mm., margins thin. Apex relatively small, sharply pointed, curved forward and downward to form a very slight hook dorsal to the base. Ornamentation consists of slight indications of transverse rugae. Shell structure and muscles scars unknown.

Remarks: The holotype and paratypes are internal moulds preserved in chert. External moulds are unknown.

Types: Holotype M. S. M. 7234, M. S. M. locality 103.2
Paratype Y. P. M. 17138, M. S. M. locality 103.2

Occurrence: Lower Theodosia formation.

Superfamily **PLEUROTOMARIACEA**
Family **RAPHISTOMATIDAE**
Subfamily **RAPHISTOMATINAE**
Genus **RAPHISTOMINA** Ulrich and Scofield (1897)
RAPHISTOMINA INFLATA

Cullison n. sp.
Plate XXVI, figures 1-2

Description: Lenticular, phaneromphalus gastropods of small to medium size with a sharply angular, carinate periphery and without a sinus or slit in the outer lip. Whorl profile plane but inclined above; gently concave in a narrow band just within and below the sharply angular carinate periphery; gently rounded on the outer two-thirds of the base and bending very sharply into the umbilicus. Sutures sharply incised beneath the periphery of the previous whorl but quite shallow. Nucleus unknown. Base strongly convex more so than spire, narrowly phaneromphalus. Columellar lip sharp and straight. Paretial inductura thin. Outer lip rather strongly oblique backwards from the upper suture, slightly convex forward close to suture and strongly concave on the outer one-half above the periphery, below the periphery nearly radial slightly concave forward close to the periphery and strongly convex forward below. Ornamentation fine lines of growth and delicate spiral lines parallel to the periphery. Shell thin and structure unknown. The holotype measures 9 mm. in height and 11 mm. in width, a paratype is 14 mm. in width, apical angle of holotype 103 degrees.

Discussion: This is one of the more prolific species of the lower Theodosia formation.

Types: Holotype M. S. M. 7201, M. S. M. locality 105.4
Paratype Y. P. M. 17139, M. S. M. locality 105.4
Paratype M. S. M. 7202, M. S. M. locality 105.4

Occurrence: The lower part of the Lutie member of the Theodosia formation.

Subfamily **HELICOTOMINAE**

Genus **OPHILETA** Vanuxem (1842)

OPHILETA SCULPTA

Cullison n. sp.

Plate XXVI, figures 3-6

Description: Low-spired discoidal, widely phaneromphalus gastropods of moderate size with many very narrow, rather deep whorls and a sinus in the outer lip. Whorl section subquadrangular, somewhat deeper than wide, the upper surface very gently convex on its inner half, very gently concave close to the peripheral angulation, a narrow flattened band close to the periphery. Periphery somewhat acutely subangular, outer face sloping inward at an angle of about 40 degrees from the horizontal, lower outer angulation rather sharply rounded, base of whorl arched approximately in the slope of the umbilical sides. Upper sutures sharply incised but shallow. Lower (umbilical) sutures moderately deep. Nucleus unknown. Base widely phaneromphalus. Inner lips not preserved, outer lip with a rather deep V-shaped sinus which culminates near, possibly just inside the periphery. Ornamentation seemingly only lines of growth which vary in intensity. Specimens incomplete but holotype measures 31 mm. in maximum diameter, 10 mm. in height and has an apical angle of 142 degrees.

Discussion: The holotype and paratypes are preserved as internal and external moulds in granular gray to buff dolomite. More incomplete conspecific specimens have been obtained preserved as internal moulds from the residual chert at Cotter, Arkansas.

Types: Holotype Y. P. M. 17140, M. S. M. locality 75.28
Paratype M. S. M. 7205, M. S. M. locality 75.28
Paratype M. S. M. 7206, M. S. M. locality 75.28

Occurrence: Lower Cotter dolomite.

Genus **OROSPIRA** (Ulrich M.S) Butts, (1926)

OROSPIRA BIGRANOSA (Ulrich M.S) Butts 1926

Plate XXVIII, figures 8-9

Description: Taken from Knight (1941). "Low-spired, discoidal, rather widely phaneromphalus gastropods with a sinus in the outer lip that culminates in an elevated keel at the angulation of the whorl in a deep notch that gives rise to a pseudoselenizone which on some specimens is to be differentiated from a true one only on subjective considerations; whorl profile flattened above, and the flattened area, within which there is one more or less sharply defined noded revolving elevation rather closer to the upper suture than to the outer margin, bordered by a sharply elevated, somewhat noded carina or notch-keel, the outer whorl face descending vertically for a short distance and then after crossing a very obscure angulation, turning roundly across the base with a sharp, irregular noded revolving carina a little within the middle of the base of the whorl; sutures sharply incised but shallow; nucleus unknown; base rather widely phaneromphalus, columellar lip thin; parital inductura thin; outer lip with a deep V-shaped sinus culminating at the carina or notch-keel in a notch or shallow slit which gives rise to a pseudoselenizone at the crest of the carina, the margin of the lip leaving the upper suture with a moderate backward obliquity which increases continually until a selenizone is reached, below the selenizone with strong forward obliquity at first which runs quickly to a radial direction which continues across the base into the umbilicus; ornamentation a noding, especially at the earlier mature growth stages of the three revolving ridges or carinae, the one close to the upper suture, the notch-keel and the carinae on the base, fine revolving lirae on the base, and rather sharp lines of growth which fasciculate as they cross the three revolving keels to form the nodes; shell thin, its structure unknown."

Remarks: The type locality given by Knight (1941) is Armstrong Mines, Christian County, Missouri. The locality is in the center of the S. ½, S. W. ¼, sec. 32, T 26 N., R. 20 W., Christian County, Missouri. The mines are abandoned pits and dumps and lie on the south bank of a small east-flowing creek. This locality is rather inaccessible and has been forgotten except by the older residents in the region.

Occurrence: The type locality is in beds which the author includes in the lower Theodosia formation.

OROSPIRA GAINESVILLENSIS

Cullison n. sp.

Plate XXVI, figures 9-10

Comparison: This species is quite similar to *O. bigranosa* but differs by having: a much higher spire, a more strongly elevated keel at the margin of the the whorls, the upper noded spiral carinae very close to the suture throughout. The aperture is not preserved on the holotype which is an internal mould.

Type: Holotype M. S. M. 7208, M. S. M. locality 106.6

Occurrence: Lower part of the Blackjack Knob member of the Theodosia formation.

OROSPIRA DEPRESSA

Cullison n. sp.

Plate XXVI, figures 11-12

Comparison: This species, the earliest known of the genus, differs from the genotype species by having: a very low spire, few if any nodes on the carinae, a more inflated outer whorl face, deeper spiral sutures, narrower whorls, and a whorl cross-section which is almost square.

Types: Holotype Y. P. M. 17141, M. S. M. locality 75.23
(small specimen)
Paratype Y. P. M. 17141, M. S. M. locality 75.23
(large specimen)
Paratype M. S. M. 7209, M. S. M. locality 75.23

Occurrence: Just above the School Mine ledge of the Rich Fountain formation.

OROSPIRA ELEGANTULA

Cullison n. sp.

Plate XXVII, figures 1-5

Comparison: This species resembles *O. bigranosa* more closely than all others. It differs from it by having the carinae located in the center of the upper whorl face, whereas it is located nearer the spiral suture in *O. bigranosa.* The surface ornamentation is otherwise like that of *O. bigranosa.*

Remarks: This is the youngest known species of the genus.

Types: Holotype Y. P. M. 17142, M. S. M. locality 106.11
Paratype M. S. M. 7211, M. S. M. locality A5.3
Paratype M. S. M. 7212, M. S. M. locality 106.11

Occurrence: Middle of the Blackjack Knob member of the Theodosia formation.

OROSPIRA ELEVATA

Cullison n. sp.
Plate XXVI, figures 13-14

Comparison: This species is, in general, similar to *O. depressa* with which it is usually associated. It differs, however, by having a higher spire, a narrower whorl and the ornamentation of nodes more pronounced on the carina which is located close to the spiral suture on the upper whorl face. Moreover, this species is smaller than the other species of *Orospira* here discussed.

Types: Holotype M. S. M. 7210, M. S. M. locality 57.1
Paratype Y. P. M. 17143, M. S. M. locality 72.42

Occurrence: Lower part of the Rich Fountain formation above the School Mine ledge.

OROSPIRA CONICA

Cullison n. sp.
Plate XXVI, figures 7-8

Diagnosis: This species of the genus, known from external moulds, is characterized by having a high conical spire, an apical angle of almost 90°, elongated nodes on the upper inner carina which is located quite near the spiral suture. This is the highest spired of the known species of *Orospira.*

Type: Holotype M. S. M. 7207, M. S. M. locality 106.4

Occurrence: Upper Rich Fountain formation

Genus **POLHEMIA**[1]

Cullison n. gen.

Diagnosis: This genus is proposed to include those low spired strongly penta-carinate, narrowly phaneromphalus gastropods of the lower Ordovician which have a definite slit in the upper outer carina and bear revolving lines as well as strong growth lines.

Comparison: This genus compares most closely with *Trochonemopsis* Meek 1872 (A. p. 83) of Devonian age, but differs from it by having a slit band and a slightly flatter spire. The cross section of the whorl is more uniformly pentagonal. In general form this genus resembles *Orospira.* It differs from this genus however by having a pentagonal whorl cross section, in being more narrowly phaneromphalus and having none of the striking ornamentation of *Orospira.*

Genotype: *Polhemia taneyensis.*

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[1] Named in honor of Mr. James Polhemus, whose untiring efforts at collecting in the field have added appreciably to the knowledge of the lower Ordovician faunas.

POLHEMIA TANEYENSIS

Cullison n. sp.

Plate XXVII, figures 6-10

Description: Medium sized narrowly phaneromphalus trochiform gastropods with five strong, carinate revolving angulations and with a shallow sinus which culminates in a slit or notch in a selinizone at the upper-outer angulation; whorl profile strongly angulated with concave or convex sections between; a salient formed rather close to the upper suture; a second salient formed at the upper-outer extremity; a third salient formed at mid-whorl; a fourth formed on the base neither so strongly carinate nor so prominent as those above, a fifth in the umbilicus; sutures deep within the groove separate the uppermost angulation from the preceding whorl; nucleus unknown; narrowly phaneromphalus; columellar lip appears very thin; paretial inductura very thin and in contact with previous whorl; outer lip with a broad shallow sinus which culminates in a narrow slit that gives rise to a selenizone; ornamentation growth lines of varying strength, and revolving lirae; shell thin, structure unknown. The incomplete holotype measures 14 mm. in diameter, and has an apical angle of 112 degrees. A complete paratype measures 13.5 mm. in diameter, 9 mm. in height and has an apical angle of 120 degrees.

Types: Holotype Y. P. M. 17144, M. S. M. locality 105.4
Paratype Y. P. M. 17145, M. S. M. locality 105.4
Paratype M. S. M. 7203, M. S. M. locality 105.4
Paratype M. S. M. 7204, M. S. M. locality 105.4

Occurrence: Basal portion of the Lutie member of the Theodosia formation.

LESEURILLA Koken 1898

The genotype of this genus has recently been redescribed and refigured by Knight (1941). The writer has experienced some difficulty in deciding whether the following species should be placed in this genus or the genus *Eccyliomphalus* Portlock (1843). The decision to place them under *Leseurilla* was made for the following reasons: the cross section of the whorls more closely resemble that of *Leseurilla;* the early portion of one specimen indicates the probable presence of partitioning septae and; the initial whorls of the spire are depressed.

Genotype: *Leseurilla infundibulum* (Koken) 1896.

LESUERILLA PLANIDORSALIS[2]

Cullison n. sp.

Plate XXVIII, figures 5-6

Description: Rather large, discoidal, widely phaneromphalus gastropods with slightly depressed spire and a slightly elevated border to the upper whorl face; whorl section subrhombic to almost square with an angulation on the upper outer end, outer face an inclined plane, inner face an inclined plane, slightly rounded below; sutures sharply incised, narrow, angular and deep in early portion of spire; nucleus not present in holotype, external moulds of paratypes indicate a diameter of less than .5 mm. with no apparent angu-

[2] Name coined by Ulrich.

lation, the latter rises on the second whorl; base of whorls slightly rounded, the umbilicus deeply concave; aperture incomplete but growth lines on external moulds of paratypes indicate margin leaves upper suture with moderate backward obliquity which continues with slight increase in obliquity and forward convexity and then strong backward obliquity to the angulation, the course of the growth line then swings strongly forward and downward across outer whorl face and across base, where there is strong forward convexity. The holotype, an internal mould, measures 42 mm. in diameter and 11 mm. ± in thickness (height). The body whorl leaves the closely coiled portion about one volution back of the aperture and digresses a maximum of about one-half the width of the whorl.

Discussion: The holotype and paratypes are internal and external moulds.

Types: Holotype U. S. N. M. Ulrich's locality 101o
Paratype U. S. N. M. Ulrich's locality 101o
Paratype Y. P. M. 17185, Ulrich's locality 101o
Paratype M. S. M. 7260, Ulrich's locality 101o

Occurrence: Lower and middle Theodosia formation.

LESEURILLA ISABELLAENSIS

Cullison n. sp.
Plate XXVIII, figures 1-4

Description: Rather large, discoidal, widely phaneromphalus gastropods with a slight to medium depressed spire and an elevated, sharply angulated border to the upper whorl face; whorl section subrhombic in early portion to suboval in later portion, with a sharp angulation on the upper outer end and slightly concave to plane in upper portion and plane below on outer face, strongly convex on inner face and strongly though broadly rounded below; sutures sharply incised, narrow, angular and deep; nucleus minute with no apparent angulation, the latter rises on the second whorl; base of whorls rounded, umbilicus medium concave; margin of the aperture as shown by the growth lines has a strong backward obliquity with a slight forward convexity from the suture to the angular border where the details of their crossing are obscure, and from where they have a strong forward and downward obliquity grading into a strong forward convexity across the base of the whorl; ornamentation very fine lines of growth only; body whorl departs from spire a distance of from one-half to almost the width of whorl at the point measured. The holotype (incomplete) measures 56 mm. in greatest diameter and the height is not known; judged from paratypes it must have been at least 18 mm.

Discussion: The holotypes and paratypes are external moulds preserved in chert.

Types: Holotype U. S. N. M. Ulrich's locality 101p
Paratype M. S. M. 7219, M. S. M. locality 106.11
Paratype Y. P. M. 17126, M. S. M. locality 106.11

Occurrence: Lower Blackjack Knob member of the Theodosia formation.

LESEURILLA GRANDIS[3]

Cullison n. sp.
Plate XXVIII, figure 7

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[3] Name coined by Ulrich.

Description: Medium sized, discoidal, widely phaneromphalus gastropods with a slightly depressed spire and an elevated, sharply angulated border to the upper whorl face; whorl section subovate in earlier portion, subrhombic in later portion with a sharp angulation on the upper outer edge. In general respects, it is similar to the other species which are described from these beds but differs in the following respects: whorl cross section changes gradually from suboval in early whorls to subrhombic in body whorl; central spire is less depressed, but more so than in *L. supraplana;* body whorl remains close to but not in contact with spire throughout its volution; ornamentation similar but less intense. The holotype, an unusual incomplete specimen, in part a hollow internal mould and in part an external mould, must have had a diameter of approximately 42 mm. and has a height of 12 mm. The paratypes are smaller.

Types: Holotype U. S. N. M. Ulrich's locality 281B
Paratype M. S. M. 7235, Ulrich's locality 281B

Occurrence: Lower part of Blackjack Knob member of Theodosia formation.

LESEURILLA SUPRACONVEXA[4]

Cullison n. sp.

Plate XXIX, figures 1-4

Description: Large, discoidal, very widely phaneromphalus gastropods with slight, if any depression of the spire and an elevated, sharply angulated border to the upper whorl face; whorl section subovate throughout with strong arch at upper inner end and a sharp angulation on the upper outer end, gently convex on outer face, more strongly convex on inner face and strongly rounded below; sutures sharply incised, narrow, angular and deep; nucleus very minute, relationship to angulation not apparent; base of whorls strongly rounded; the umbilicus only slightly concave; apertural margin shown by growth lines which leave upper suture with moderate backward obliquity and continue with increase in obliquity and moderate forward convexity up to crest where their crossing is not apparent; the course of the growth lines on the outer face is with forward obliquity grading into strong forward convexity at base of whorl; ornamentation very coarse lines of growth only. Complete holotype must have measured 55 mm. in greatest diameter and 13 mm. in thickness (height).

Discussion: The holotype and paratypes are silicified internal moulds in chert with very little silicified shell remaining.

Types: Holotype U. S. N. M. Ulrich's locality 281B
Paratype M. S. M. 7261, Ulrich's locality 281B
Paratype Y. P. M. 17186, Ulrich's locality 281B

Occurrence: Middle and upper Theodosia formation.

LESEURILLA MAGNA

Cullison n. sp.

Plate XXIX, figures 5-8

Description: Very large, discoidal, widely phaneromphalus gastropods with a medium depressed spire and an elevated, sharply angulated border to the upper whorl face; whorl section subrhombic with a sharp angulation in the upper outer end, very slightly convex (almost a vertical plane) on outer face, strongly convex on inner face, and slightly rounded to almost flat below; sutures sharply incised, narrow, angular and deep; nucleus small; base of whorls relatively flat, umbilicus moderately concave; apertural margin as shown by growth lines, which are very few on these specimens, indicates an asymmetrical sinus which culminates at the angulation; ornamentation apparently only growth lines of varying intensity. The holotype measures 71 mm. in diameter and 22 mm. in thickness (height).

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[4] Name coined by Ulrich.

Discussion: The holotypes and paratypes are silicified internal and external moulds. No shell is preserved and the ornamentation is only partially preserved on the external moulds.

Types: Holotype M. S. M. 7220, M. S. M. A5.6
Paratype Y. P. M. 17187, M. S. M. locality A5.6
Paratype U. S. N. M. M. S. M. locality A5.6

Occurrence: In the "Black Ledge" of the Powell dolomite.

Family **PLEUROTOMARIIDAE**
Subfamily **EOTOMARIINAE**
Genus **EOTOMARIA** Ulrich and Scofield (1897)
EOTOMARIA DEPRESSA
Cullison n. sp.
Plate XXX, figures 7-11

Description: Turbinate, narrowly phaneromphalus gastropods with sharply angular whorls and a rather narrow V-shaped sinus in the outer lip culminates either on the upper side or at the periphery which gives rise to a narrow flat band that represents a selenizone; whorl profile above the periphery slopes outward at an angle of about 24 degrees with the horizontal, slightly arched in the upper two-thirds gently concave in the lower third, the periphery subangular, below the periphery slopes gently rounded into the umbilicus; sutures sharply incised below the periphery more deeply in early growth stages than later; nucleus unknown; base gently rounded narrowly phaneromphalus; ornamentation not preserved. The holotype consists of approximately four whorls, must have had a height of 18 mm. before breakage, a width of 35 mm. and a pleural angle of 133 degrees.

Discussion: The holotype and paratypes are internal moulds preserved in a granular gray to buff dolomite. They have been veneered by a thin layer of crystalline calcite which tends to obscure any fine ornamentation.

Types: Holotype Y. P. M. 17146, M. S. M. locality 75.28
Paratype M. S. M. 7213, M. S. M. locality 75.28
Paratype M. S. M. 7214, M. S. M. locality 75.28

Occurrence: Lower Cotter dolomite and possibly the Theodosia formation.

Family **MURCHISONIIDAE**
Subfamily **HORMOTOMINAE**
Genus **HORMOTOMA** Salter (1859)
HORMOTOMA DUBIA
Cullison n. sp.
Plate XXX, figures 14-15

Description: High spired, anomphalus gastropods of many bead-like whorls and with a V-shaped sinus in the outer lip culminating at a little above the middle whorl face in what may be a notch that gives rise to a selenizone; whorl profile rounded between sutures and slightly angulated at selenizone; sutures deep; nucleus unknown; base unknown; ornamentation very imperfect.

Discussion: The holotype and paratype are both incomplete. They are internal moulds preserved in light gray chert. They are the largest high spired gastropods known this low in the Missouri section. The rate of expansion of the apical portion of the spire is not uniform. The initial three whorls expand at a more rapid rate than the remainder of the whorls. In this respect it differs from other species which are present in the overlying formations.

Types: Holotype M. S. M. 7196, M. S. M. locality 72.51
Paratype Y. P. M. 17147, M. S. M. locality 57.1

Occurrence: Lower Rich Fountain formation.

HORMOTOMA LUTIENSIS
Cullison n. sp.
Plate XXX, figures 12-13

Description: High spired anomphalus gastropods of at least eight bead-like whorls; whorl profile rather strongly rounded between sutures, slightly angulated just below center of outer whorl face; sutures rather deep; nucleus unknown; ornamentation unknown; shell thin, its structure unknown, a complete specimen must have measured at least 16 mm. in length and 4½ mm. in width at the base. The apical angle is approximately 16 degrees on the holotype.

Discussion: The holotype and paratypes are internal moulds preserved in a granular black and white iron-stained chert which is a coquina of these forms.

Types: Holotype M. S. M. 7199, M. S. M. locality 106.24b
Paratype Y. P. M. 17148, M. S. M. locality 106.24b
Paratype M. S. M. 7200, M. S. M. locality 106.24b
Paratype Y. P. M. 17149, M. S. M. locality 106.24b

Occurrence: "Black and white" chert bed of the upper part of the Lutie member of the Theodosia formation.

HORMOTOMA COTTERENSIS
Cullison n. sp.
Plate XXX, figures 4-6

Description: High spired, anomphalus gastropods of at least 10 bead-like whorls with probably a deep V-shaped sinus in the outer lip, culminates at about the middle of the whorl face in what may be a notch that gives rise to a selenizone; whorl profile rounded between sutures bearing a raised ridge having a width of about one-eighth the height of the whorl at the center of the outer face; sutures deep; nucleus unknown; base rounded, seemingly anomphalus, apertural characteristics unknown; ornamentation unknown; shell thin, structure unknown. The holotype bears ten whorls in the apical 33 mm. and measures 9.6 mm. in width on the tenth whorl. The apical angle is approximately 16½ degrees.

Discussion: The types are in a saccroidal, medium grained gray to buff dolomite and are external and internal moulds upon which there has been deposited a film of crystalline calcite of sufficient thickness to obliterate the ornamentation.

Types: Holotype M. S. M. 7198, M. S. M. locality 75.28
Paratype Y. P. M. 17150, M. S. M. locality 75.28

Occurrence: Lower Cotter dolomite.

HORMOTOMA POWELLENSIS

Cullison n. sp.
Plate XXX, figures 1-3

Description: High spired, anomphalus gastropods of at least nine bead-like whorls and with probably a deep V-shaped sinus in the outer lip which culminates at a little below the middle of the whorl face in what may be a mere notch that gives rise to a selenizone; whorl profile roughly rectangular, compressed laterally between sutures, slightly angulated at the lower margin of the selenizone; sutures deep; nucleus unknown; base rounded, seemingly anomphalus; columellar lip almost straight rounded below without channeling; paretial lip not known; outer lip unknown; ornamentation imperfect, shell thin, its structure unknown. A complete mature specimen must have measured at least 80 mm. in height and 20 mm. in width. The paratype has a pleural angle of 14½ degrees.

Discussion: The holotype is an external mould preserved in red porous chert. A rubber cast has been made which shows some of the external features. The paratype is an internal mould preserved in the same type of material.

Types: Holotype M. S. M. 7197, M. S. M. locality A5.6
Paratype Y. P. M. 17151, M. S. M. locality A5.6

Occurrence: "Black Ledge" of the Powell dolomite.

Superfamily **EUOMPHALACEA**

Family **MACLURITIDAE** Woodward

Genus **CERATOPEA** Ulrich (1911, p. 665)

Discussion: This genus was erected by Ulrich (1911) to include the peculiar type of fossil opercula, distributed through the "Upper Canadian" and found by him to be widespread in distribution in North America. He designated as the genotype *Ceratopea keithi* Ulrich, a specimen figured by Bassler (1906) in the Virginia Geological Survey Bulletin II-A. Ulrich designated no species other than *C. keithi*, but mentioned varieties of this species.

Butts (1926) illustrated two Arkansas and two Alabama specimens as the same species, in the Alabama Special Report 14. In the legend of Plate 18 of that report he states that the Arkansas specimens are from the Cotter and Powell dolomites.

Oder (1932) has described a number of species of this genus from the lower Ordovician limestones and dolomites of East Tennessee. In his discussion he orients the operculum in a manner similar to that used by Salter (1859) in his orientation of the operculum of *Maclurea logani*. The orientation used by Oder suggests that all the known species of *Ceratopea* are opercula of sinistrally coiled gastropods. Based upon field observations and collections made in Missouri, Arkansas and at a number of localities in East Tennessee, the writer feels confident in saying that there are few, if any, gastropods in these formations which are sinistrally coiled. Therefore, Oder's orientation of *Ceratopea* is not here followed. The true orientation of the operculum to the parent shell will be known only when some fortunate collector finds the two associated.

From a description of the holotype by Knight (1941), who applied Bridge's concepts of orientation and function, it appears that he believed the companion valve of *Ceratopea* to be a dextrally coiled shell.

Two possible explanations of the lack of gastropods remains of sufficient size to fit these opercula are: first, the operculum, although smaller than the shell, has a greater weight for its size because it is a more compact mass, a condition which would allow the sorting action of currents to separate the two and deposit each in a different area; second, most specimens of *Ceratopea* thus far described are relatively free, silicified forms which have been collected from the residual soil. This condition is characteristic of localities which are very deeply weathered. The massive character of the operculum as related to the fragile character of the shell is such that the former would be included in its entirety in the residuum, whereas the latter, under similar conditions, would be completely disintegrated.

The writer has numerous collections in chert in which the Ceratopeas and the spiral shells might match if they could both be completely freed from the matrix.

At locality 75.28 in Jefferson County, Missouri, numerous specimens of large gastropods and Ceratopea occur together. Here, the spiral shells are represented by internal moulds in dolomite but unfortunately the apertures are incomplete. The Ceratopea occur as external moulds in the dolomite. No matching specimens have been found in this collection. Attention should be called to the fact that no sinistrally coiled gastropods are present in this rather large collection.

The writer is informed that Dr. Josiah Bridge has in preparation a monographic study of *Ceratopea* which is due to be completed shortly. Until this work is published, the precise method of orientation is not available. Therefore, the author will use the terminology and orientation as it can be inferred from Knight's discussion of the genotype.

Genotype: *Ceratopea keithi* Ulrich.

CERATOPEA JENKINENSIS

Cullison n. sp.

Plate XXXI, figures 1-6

Description: A tooth-shaped operculum with a very large and deep depression at the attached end; the operculum oriented with the depression of attachment down, when viewed from the apex, is sinistrally bent and is sharply subangular or subcarinate above the center on the outer edge. Carina straight, lies in a plane throughout its length which is the full length of the operculum. The character of the rim around the depression of attachment is best described in the figures.

Discussion: These are the largest specimens of the genus found during this study. They differ from all other species by having a very deep internal cavity which is smaller than the entire shell only by an amount equal to the thickness of the wall. To account for this unusually deep attachment pit the writer has considered the possibility that the attachment surface in the pit may not have been preserved during silicification, but this explanation does not account for the core of matrix which reaches to the tip of the cavity. Had the attachment surface been well removed from the apex, it is plausible that between the apex and the attachment surface there would have been shell material. During or previous to silicification this shell material must have been removed. This would have left a void surrounded by an external mould, or a layer of replaced shell material around the periphery. A number of broken specimens in the author's collections show that the silicified preservation of the wall of this species is composed of three layers. The inside and outside wall are the same type of dense chert. These two layers join over the outer margin of the attachment cavity. Between the two is a thin layer of irregular thickness which is made up of small quartz crystals. Commonly, this portion of a silicified specimen is only partially filled and the remainder is either void or contains iron-stained clay. This latter is especially apparent in those specimens which have either the exterior or interior layer fractured. This feature extends to the tips of these specimens and substantiates even more completely the fact that the original shell had a very large and deep interior pit.

Types: Holotype M. S. M. 7244, M. S. M. locality A4.2
Paratype M. S. M. 7245, M. S. M. locality A4.7
Paratype Y. P. M. 17157, M. S. M. locality A4.7

Occurrence: Upper Cotter formation, Jenkins Branch beds.

CERATOPEA ANKYLOSA

Cullison n. sp.

Plate XXXI, figures 13-18

Description: A medium sized operculum which not only has a very strong clock-wise twist but is very strongly bent to the left when the dorsal surface is viewed from the apex. The bend is almost, if not, at an angle of 90 degrees. Muscle attachment cavity roughly rectangular to slightly oval, shallow and containing two pits, one at the extreme left and the other at the extreme right. The pit to the extreme left in a dorsal view from the apex is usually the deeper and more pronounced. Ventral and dorsal surfaces relatively flat, outer convex face broadly rounded and not carinate. Suggestions of a broad, faint central groove are present in the dorsal surface.

Remarks: This species resembles in outline the species described by Oder as *C. corniformis*. It differs by having the dorsal and ventral surfaces equally inflated, and a muscle attachment cavity containing two pits. Concerning this last difference, Oder's description is not specific other than to state the depth of the cavity as being one-fifth or less than the length of the shell.

Types: Holotype M. S. M. 7247, M. S. M. locality A4.2
Paratype Y. P. M. 17159, M. S. M. locality A4.2

Occurrence: Upper Cotter dolomite, Jenkins Branch beds.

CERATOPEA TENNESSEENSIS Oder (1932)

Plate XXXI, figures 37-38

Discussion: Specimens appearing to be the equivalent of this species have been collected from beds outcropping in Jefferson County, Missouri, locality 75.19. The precise position of the fauna in the section is known but the beds in this region have not been correlated definitely with those in the type areas. The writer is confident, however, that the beds are post-Rich Fountain and pre-upper Cotter in age.

Compared with *C. jenkinensis* which it resembles superficially; the dorsal surface of this species is less inflated; has a shallower muscle attachment pit extending about one-third the length; is slightly smaller; and the carina, although it lies in a plane, is not as strong.

Types: Hypotype M. S. M. 7251, M. S. M. locality 75.19
Hypotype Y. P. M. 17162, M. S. M. locality 75.19
Hypotype Y. P. M. 17188, M. S. M. locality 75.19

Occurrence: Theodosia formation and lower Cotter dolomite.

CERATOPEA SUBCONICA Oder (1932)

Plate XXXI, figures 34-36

Discussion: This species is represented in the writer's collection by only one specimen. It appears to be almost a duplicate of the type as figured by Oder. This specimen is elongate and narrow. The maximum length is 27 mm., and the width in the plane of the aperture is 15 mm. The maximum width normal to the length is 12 mm. The distinct, slightly rounded carina does not lie in a plane but when viewed from the apex, with the shell oriented with the muscle pit down, has a counter-clockwise twist. Shape of aperture roughly oval.

Type: Hypotype M. S. M. 7250, M. S. M. locality 105.24

Occurrence: Middle Lutie member of the Theodosia formation.

CERATOPEA CAPULIFORMIS Oder (1932)

Plate XXXI, figures 7-12

Description: This particular species is characterized by its strongly inflated dorsal surface, shallow muscle attachment pit and strongly recurved, narrow, acuminate apex. The size is relatively small. The carina is very distinct and shows a strong counter-clockwise twist when viewed from the apex. Shape of aperture roughly subquadrate.

Types: Hypotype M. S. M. 7246, M. S. M. locality 75.23
Hypotype Y. P. M. 17158, M. S. M. locality 75.23

Occurrence: Rich Fountain formation at Missouri localities 75.23, 72.50 and 106.2 in the residual chert nodules.

CERATOPEA TORTA

Cullison n. sp.

Plate XXXI, figures 19-24

Description: This species is very elongate, narrow and strongly acuminate. The carina is strong and when viewed from the apex appears to have been twisted through about 90 degrees in a counter-clockwise direction. Aperture is broadly oval. The muscle attachment pit is an asymmetric cone with the deepest portion near the side opposite the carina. Length of the holotype 30 mm., width in plane of aperture 12 mm., minimum width at aperture 10 mm. Both the dorsal and ventral side about equally inflated. This species is characterized by its elongate, narrow outline, strongly biconvex transverse section, simple shallow attachment pit and very strong twist.

Types: Holotype Y. P. M. 17160, M. S. M. locality 103.2
Paratype M. S. M. 7248, M. S. M. locality 103.2

Occurrence: Lower part of the Lutie member of the Theodosia formation at Missouri localities 106.26, 103.2, and 72.49.

CERATOPEA JONESI

Cullison n. sp.

Plate XXXI, figures 31-33

Description: Acuminate, elongate operculum having very little twist in the carina. Aperture roughly subquadrate. Muscle attachment pit very shallow with tip almost central and ventral. Size is medium to large in comparison with other species. Carina prominent but not a strong ridge.

Type: Holotype M. S. M. 7249, M. S. M. locality 106.7

Occurrence: Lower part of the Blackjack Knob member of the Theodosia formation.

CERATOPEA INFLATA

Cullison n. sp.

Plate XXXI, figures 39-41

Description: Operculum, thick, and blunt. Apex, approximately a right angle, located to the right of the center line in a dorsal view. Carina prominent but not strong, lies in a plane and is curved uniformly from apex to aperture. Aperture subquadrate to oval. Muscular attachment pit apparently shallow but not well exposed in holotype. Ventral surface more strongly inflated than dorsal. The central portion of the operculum is inflated. The cross section at the aperture is smaller in area than the transverse section at midlength. This species is characterized by its central obesity and constricted shallow aperture.

Type: Holotype M. S. M. 7252, M. S. M. locality A4.14

Occurrence: Lower part of the Blackjack Knob member and the Lutie member of the Theodosia formation. In the Lutie member this species is associated with the trilobite genus *Lutesvillia* at locality 92.8.

CERATOPEA SUPRAPLANA

Cullison n. sp.

Plate XXXI, figures 25-30

Description: This operculum is medium to small in size. The carina is present but very inconspicuous, and only slightly curved in a plane. The apex is blunt and flattened. The dorsal surface in the holotype is flat to only slightly inflated. The muscle attachment pit is shallow, oval and slightly quadrate in outline. Surface smooth, but this character may be due entirely to preservation.

The diagnostic features of this species are the almost centrally located apex, the lack of a strongly twisted carina, and the low flat dorsal surface.

Types: Holotype Y. P. M. 17161, M. S. M. locality 106.7
Paratype M. S. M. 7262, M. S. M. locality 106.7
Paratype U. S. N. M. M. S. M. locality 106.7

Occurrence: Middle Theodosia formation.

Class **CEPHALAPODA**

Family **DELTOCERATIDAE** Ulrich, Foerste, Miller & Furnish (1942)

Genus **SHUMARDOCERAS** Ulrich and Foerste (1935)

SHUMARDOCERAS COMPLANATA (Shumard) (1862)

Plate XXXII, figures 1-4

Description: These specimens are typical representatives of *S. complanata*. They consist of about two to two and one-fourth volutions, all of which are in contact with the exception of the adoral portion of the living chamber. The maximum diameter attained by the more complete of these two specimens is about 23 mm., and the maximum height and width of conch measure about 8 mm. and 5 mm., respectively. No traces of surface ornamentation of the tests is discernible (the specimens are internal moulds). The siphuncle is small and ventral but not quite marginal. The general physiognomy of the conch, the shape of sutures, average size, stratigraphic and geographic location in relation to the region of the type locality are typical of the species.

Types: Hypotype M. S. M. 7221, M. S. M. locality 105.17
Hypotype Y. P. M. 17127, M. S. M. locality 106.25b

Occurrence: Lower Theodosia formation, a characteristic fossil of the "Black and White" chert bed.

SHUMARDOCERAS LUTIENSIS

Cullison n. sp.
Plate XXXII, figures 10-12

Description: Conch discoidal, 30 mm. in maximum diameter, consists of approximately two and one-half volutions; umbilicus not clearly defined, probably perforate; whorls sub-elliptical in cross section, in contact throughout except for approximately the latter half of the living chamber which diverges, not impressed, adoral end of an apparently mature specimen 9 mm. high and 6 mm. wide; siphuncle 1.6 mm. in diameter, ventral but not marginal; sutures form lateral lobes and dorsal and ventral saddles; ornamentation and growth lines not preserved in known specimens; aperture commonly absent, on the holotype, however, there is a suggestion of a slightly subterminal aperture, which may be due to the mode of preservation.

Remarks: This species resembles quite closely *S. complanata* but differs in being more inflated laterally, more rounded ventrally, and in all known specimens is approximately one and one-half times as large. Specimens are preserved in porous gray iron-stained chert.

Types: Holotype M. S. M. 7224, M. S. M. locality 106.25b
Paratype Y. P. M. 17128, M. S. M. locality 106.25b
Paratype U. S. N. M. M. S. M. locality 106.25b

Occurrence: Massive dolomite beds below the "Black and White" chert and above the Rockaway conglomerate beds of the Lutie member of the Theodosia formation.

Genus **APHETOCERAS** Hyatt (1894)

APHETOCERAS SUBCOSTULATUM Ulrich, Foerste Miller & Furnish (1942)

Plate XXXIII, figures 6-9

Description: These specimens are typical representatives of the species. They consist of fragments of volutions including as much as one-half volution. The largest specimen, measured along the convex ventral outline, is about 165 mm., slightly less than one-third of which represents poorly preserved phragmacone. The amount of curvature increases adapically. Conch, oval in cross section, ratio of height to width about 1.24, laterally compressed slightly, more narrowly rounded ventrally than dorsally. The height of the living chamber increases from 16 mm. at the junction of the phragmacone to 22 mm. at the aperture. The surface of the internal mould is marked by fine growth lines and low rounded ribs or costae. The growth lines form rounded, fairly deep ventral sinuses. The irregularly spaced costae are commonly parallel to the growth lines. The siphuncle is composed of cylindrical segments, and at the junction of the living chamber and phragmacone where the conch is 14 mm. high, it has a diameter of 2.7 mm. and lies about ¾ mm. above the ventral margin.

The volutions of this species are for the most part not in contact. A cast of an external mould shows none of the later volutions in contact, but at the adapical portion where, although it is incomplete, the test is quite small, which suggests that probably not more than one and one-half volutions were in contact. The apertural end of the penultimate whorl is quite distantly removed from the previous whorl. Fragments of phragmacones indicate that the sutures have broad lateral lobes and broad ventral saddles. The septae are strongly convex adapically.

Remarks: This species resembles *A. ozarkensis* but differs in being much larger, and in having a more oval cross section.

Hypotypes: M. S. M. 7239, M. S. M. locality 72.51
Y. P. M. 17154, M. S. M. locality 72.51
M. S. M. 7240, M. S. M. locality 72.51

Occurrence: From chert nodules above the School Mine ledge of the Rich Fountain formation.

APHETOCERAS OZARKENSIS

Cullison n. sp.
Plate XXXIII, figure 13

Description: Conch discoidal, 60 mm. in diameter as measured from adapertural end of living chamber to opposite side of whorl; number of volutions unknown; three-fourths present in holotype and paratype; umbilicus unknown; whorls circular in cross section becoming only slightly laterally compressed adaperturally, and not in contact in later stage of development during which the living chamber diverges quite rapidly, height 12 mm., width 11.5 mm. at junction of living chamber and phragmacone; siphuncle 3 mm. in diameter, composed of cylindrical segments, ventral but not quite marginal; sutures form broad, shallow, lateral lobes and narrow ventral saddles; camerae short, 13 in 10 mm. measured on ventral margin; ornamentation not preserved on types; aperture not preserved on types.

Remarks: This species resembled *A. subcostulatum* with which it is associated but differs by being smaller, having a higher curvature, shorter camerae and no apparent ribs on the living chamber.

Types: Holotype M. S. M. 7242, M. S. M. locality 72.51
(the more complete specimen)
Paratype M. S. M. 7242, M. S. M. locality 72.51

Occurrence: Nodular chert above the School Mine ledge of the Rich Fountain formation.

Family **TARPHYCERATIDAE** Hyatt (1894)

Genus **CAMPBELLOCERAS** Ulrich and Foerste (1935)

CAMPBELLOCERAS SIMPLEX

Cullison n. sp.
Plate XXXII, figures 7-9

Description: Conch subdiscoidal, 70 mm. in maximum diameter; whorls subcircular in cross section, somewhat compressed laterally, slightly flattened dorsally; near adoral end 25 mm. high, 22 mm. (estimated) wide; living chamber two-fifths of last volution; apertural margins slightly flared; growth lines curve apicad from umbilical seam and form a deep rounded ventral sinus; sutures directly transverse, essentially straight except in adoral portion of phragmacone where they form very slight lateral lobes; siphuncle ventral and marginal, 2½ mm. in diameter in adoral portion of phragmacone, composed of cylindrical segments.

Remarks: The specimen is a well preserved internal mould which is essentially complete adorally but not adapically. It will have to be carefully compared with the illustrations of co-generic forms, when they are available.

Types: Holotype M. S. M. 7223, M. S. M. locality 75.28
Paratype Y. P. M. 17189, M. S. M. locality 75.28
Paratype U. S. N. M. M. S. M. locality 75.28

Occurrence: Lower Cotter dolomite.

Genus **CENTROTARPHYCERAS** Ulrich and Foerste (1935)

CENTROTARPHYCERAS YELLVILLENSIS

Ulrich, Foerste Miller & Furnish (1942)
Plate XXXII, figure 20
Plate XXXIII, figures 1-3

Discussion: This species described by Ulrich, Foerste, Miller and Furnish in a special paper of the Geological Society of America is based on fragmentary specimens. The writer has been fortunate to find a locality where specimens can be obtained in abundance and their position in the stratigraphic section is definitely established.

Description: Conch large; in fully mature specimens attains a diameter up to at least 175 mm.; living chamber about one-half volution in length and divergent at the adapertural end in mature specimens; whorls depressed, broadly rounded to somewhat flattened ventrally, more narrowly rounded laterally, distinctly impressed dorsally; sutures form fairly deep dorsal, and extremely shallow lateral lobes; siphuncle large, 4 mm. in diameter at junction of living chamber and phragmacone, almost central, composed of cylindrical segments; ornamentation consists of growth lines parallel to the apertural margin.

Types: Hypotype Y. P. M. 17152, M. S. M. locality A5.6
Hypotype Y. P. M. 17153, M. S. M. locality A5.6
Hypotype M. S. M. 7236, M. S. M. locality A5.6
Hypotype M. S. M. 7237, M. S. M. locality A5.6

Occurrence: "Black Ledge" of the Powell dolomite.

CENTROTARPHYCERAS (?) BAXTERENSIS

Cullison n. sp.
Plate XXXIII, figures 4-5

Description: This specimen, represented by fragments of the last two whorls, appears to have been about 145 mm. in diameter. The shape and size is quite similar to *C. yellvillensis* but the position of the siphuncle is very slightly ventral to the center, and the whorls are ornamented by prominent lateral ribs which follow the growth lines as they curve adapically from the umbilical seam to the flattened venter, which they do not cross. On the living chamber of the holotype, these ribs average 13½ mm. from center to center and are at least 2 mm. high. *Type*: Holotype M. S. M. 7238, M. S. M. locality A5.6

Occurrence: "Black Ledge" of the Powell dolomite.

Family Undetermined

Genus **PILOTOCERAS**

Cullison n. gen.

Diagnosis: This genus is proposed to include those small nautiloid cephalopods which have subterminal apertures, cordate whorls, and siphuncles located ventral to the center.

Genotype: *Pilotoceras brunei.*

PILOTOCERAS BRUNEI[5]

Cullison n. sp.

Plate XXXII, figures 5-6

Description: Conch discoidal, 28 mm. in maximum diameter and 4.5 mm. in maximum thickness on the living chamber; whorls, about three in contact except in extreme adoral portion; living chamber two-fifths of volution in length, cordate cross section slightly impressed dorsally, compressed and flattened laterally and subangular ventrally; lateral zones which converge laterally are almost flat but very slightly concave; near adoral portion about 8 mm. high, 5 mm. wide. Aperture not well preserved in this specimen but appears to resemble that of *Moreauoceras milleri* which suggests that after the conch had reached full maturity the dorsal and lateral portions of the test rounded over the dorsal part of the aperture and the aperture thus became subterminal and ventro-lateral in position followed by a slight flaring of the walls. Sutures slightly sinuous, each form a ventral saddle, a broad shallow lateral lobe, an asymmetrical dorso-lateral saddle and a slight dorsal lobe. Siphuncle not clearly defined but a structure which appears to represent it is small in size, located somewhat ventral of the center of the conch.

Remarks: Only one representative of this species is available for study. It is preserved in white chert. Although portions of the apertural margin are covered with matrix, the general nature of the aperture can be ascertained with a fair degree of certainty.

Holotype: M. S. M. 7222, M. S. M. locality 72.42

Occurrence: Middle Rich Fountain formation in the zone above the School Mine ledge.

Genus **MOREAUOCERAS**

Cullison n. gen.

Diagnosis: This genus is proposed to include those small nautiloid cephalopods which have a subterminal aperture, subcircular, dorsally impressed whorls and a ventral marginal siphuncle.

Genotype: *Moreauoceras milleri.*

MOREAUOCERAS MILLERI[6]

Cullison n. sp.

Plate XXXII, figures 13-19

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[5] Named for Mr. Arthur Brune who collected this specimen.

[6] Named in honor of Dr. A. K. Miller in appreciation of his interest and assistance.

Description: Conch subdiscoidal, approximately 20 mm. in maximum diameter, consists of about two and one-half volutions; umbilicus appears to be perforate; whorls subcircular in cross section, slightly impressed dorsally, near adoral end of complete mature specimen height is about 7 mm., width about 7½ mm., depth of impressed zone about ½ mm.; siphuncle composed of cylindrical segments, small (diameter, ⅛ that of conch) in size, ventral and marginal; sutures sinuous and form ventral saddles, a ventro-lateral lobe, a dorso-lateral saddle, and a dorsal lobe; surface ornamentation, numerous fine growth lines which are somewhat fasciculate except in the immediate vicinity of the aperture of fully mature specimens; aperture, growth lines which indicate the shape of aperture during ontogenetic development curve apicad from umbilical seam and form a rounded ventral sinus, at maturity it is modified in that the dorsal and dorso-lateral portions of the test round over the dorsal part of the aperture and the aperture becomes subterminal and ventro-lateral in position, the construction thus resulting again expands into a slight flare.

Remarks: Two specimens of this species, preserved in white chert, are available for study. Both consist of internal moulds of the adapertural portions of the outer volutions of the conch and external moulds of the inner volutions.

Types: Holotype Y. P. M. 17129, M. S. M. locality 57.1
Paratype M. S. M. 7225, M. S. M. locality 57.1

Occurrence: Lower Rich Fountain formation in the faunal zone 30 feet above School Mine ledge.

Genus **DYSCRITOCERAS** Ulrich and Foerste (1935)

DYSCRITOCERAS JEFFERSONENSIS

Cullison n. sp.
Plate XXXIII, figures 14-15

Description: Conch breviconic, curved lengthwise to a radius of approximately 115 mm., slightly compressed laterally with a lateral diameter of 13 mm. at junction of living chamber and phragmacone; camerae numerous, 1 mm. in length; sutures of the septae almost straight; siphuncle small, approximately 1 mm. in diameter, cylindrical in form, very close to, but not in contact with, convex wall of the conch; living chamber deep, approximately one-third of the length of the conch.

Holotype: M. S. M. 7243, M. S. M. locality 75.28.

Occurrence: Lower Cotter dolomite.

Genus **CYPTENDOCERAS** Ulrich and Foerste (1935)

CYPTENDOCERAS MAGNUS

Cullison n. sp.
Plate XXXIII, figures 10-12

Description: An orthoconic, holochoanoidal conch, very slightly compressed dorso-ventrally. The holotype is 150 mm. long and retains approximately 23 mm. of the adapical part of the living chamber. In a paratype figure 12, Plate XXXIII, the lateral diameter is 26 mm. and the dorso-ventral is 25 mm. at the base of the living chamber. Adapically the conch appears to be slightly more flattened. Within a length of 30 mm. there are 18 camerae. The sutures of the septae reach their highest elevation ventrad of the middle of the lateral sides and thence curve down ventrally forming ventral lobes 3 mm. deep. The concavity of the septae equals about 5 mm. laterally just above the siphuncle. Siphuncle is relatively large, approximately 11 mm. in lateral diameter at the base of the living chamber and lies in contact with the ventral wall of the conch.

Remarks: This species appears to resemble closely *C. ruedemanni* Ulrich and Foerste (1935) but is less compressed dorso-ventrally, has a larger siphuncle and fewer camerae per unit of length.

Types: Holotype Y. P. M. 17155, M. S. M. locality 75.28
Paratype Y. P. M. 17156, M. S. M. locality 75.28
Paratype M. S. M. 7241, M. S. M. locality 75.28

Occurrence: Lower Cotter dolomite.

Phylum **ARTHROPODA**
Class **CRUSTACEA**
Subclass **TRILOBITA**
Order **OPISTHOPARIA**
Family **BATHYURIDAE** Walcott
Genus **BATHYURELLUS** Billings (1865)
BATHYURELLUS PERMAGINATUS
Cullison n. sp.
Plate XXXIV, figures 23-24

Description: This species is based on pygidia from a number of localities. The cranidia are uncertain.

Pygidium bounded by a broad flat border the width of which at the anterior end is equal to the greatest width of the axial lobe. In the holotype this measures 4 mm. Pleural furrows very slightly impressed on border. Axial lobe strongly convex, bounded laterally by strong axial furrows which do not continue around the posterior end but fade out at the edge of the margin where the axial lobe extends slightly on to the margin. Axial lobe bears four faintly marked segments. Pleural lobes roughly triangular, convex, bear four pleural furrows, the intensity of which diminishes posteriorly.

Surface of pygidium smooth.

Types: Holotype Y. P. M. 17170, M. S. M. locality 72.50
Paratype M. S. M. 7165, M. S. M. locality 72.50
Paratype U. S. N. M. Ulrich's locality 101y

Occurrence: Rich Fountain formation.

Genus **JEFFERSONIA** Ulrich (in Poulsen, 1927)

Discussion of the Genus: This name, ascribed to Ulrich, was first published by Poulsen (1927). At that time he described one species and stated that the generic description was being left to Ulrich. This procedure, however, has made the species *Jeffersonia exterminata* Poulsen, the genotype of *Jeffersonia* by monotypy and established the genus *Jeffersonia* as based on that species. As a result of this, the type of the genus is a species represented by a single pygidium obtained from the Nunatami formation at Nunatami on the south coast of Washington Land, Greenland, by Lauge Koch while on the Second Thule Expedition. Poulsen acted apparently with the full knowledge of Ulrich, who made available to him collections of lower Ordovician trilobites from Missouri and Arkansas. In the light of this, it must be assumed that Ulrich recognized the pygidium as being a species of his manuscript genus *Jeffersonia* although he may not have realized that the publication of the species description would make it the genotype.

The writer has been confronted with two choices in this matter: 1. To accept this specimen as the genotype and proceed to set forth the salient features of the genus based on Ulrich's collections and many additional specimens of his own; 2. To disregard the possible generic relationship of the Missouri and Arkansas species with that from Greenland and erect a new genus. Both choices are subject to criticism. The author will follow the first because: it is according to the rules of nomenclature, and Ulrich recognized Poulsen's specimen as being a species of his manuscript genus. The writer has not had the opportunity to study the genotype and must rely on the above stated facts to support his case for continuing the use of the generic name *Jeffersonia.*

Those features which are characteristic of the genus, and which were derived from studies of species in the United States Geological Survey collections and the author's collections, are described below.

Carapace: None known.

Cephalon: Semicircular with lateral posterior spines. Cranidium composed of rectangular, elongate, anteriorly rounded glabella which bears two pairs or commonly no glabellar furrows; fixed cheeks large; facial suture directed forward or slightly outward and forward; frontal limb broad or narrow, posterior portion of free cheek high in vicinity of palpebral lobe and slopes sharply to strong occipital furrow. Anterior margin thickened and appears as a ridge or upturned edge. Free cheek: lateral margin a raised, thickened ridge or upturned edge produced posteriorly into a genal spine; palpebral area relatively high; eye elongate, semicircular. Facial suture cuts porterior margin just inside of genal angle.

Thorax: Very little is known. Up to 9 segments have been observed. Pleural furrows strong. Pleural segments terminate laterally in flattened margin and where observed are the "plévre á sillon" type.

Pygidium: Semicircular to elongate semicircular, composed of five segments. Margin broad to narrow, flat or concave with prominent doublure or an upturned edge. Margin distinct and is not crossed by furrows. Posterior margin rounded. Axial lobe strongly convex, conical, sharply set off by deeply incised furrows, terminates anterior to margin.

Surface of carapace may be smooth or granulose.

Genotype: *Jeffersonia exterminata* Poulsen (1927).

JEFFERSONIA MISSOURIENSIS[7]

Cullison n. sp.

Plate XXXIV, figures 10-16

Description: Cephalon: no complete cephalon known, commonly represented by cranidium which consists of glabella, fixed cheeks, anterior margin and occipital segment. Glabella: smooth, subquadrangular, evenly rounded anteriorly, sharply terminated posteriorly by occipital furrow, ratio of length to width 1.4—, strongly arched transversely and longitudinally, bears no glabellar furrows. Fixed cheeks; medium sized, slightly raised and edged with narrow brim in vicinity of palpebral lobe. Frontal limb slightly convex. Facial sutures digressing outward from in

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[7] Species name coined by E. O. Ulrich.

front of the eye to where they cut directly across the anterior margin. Occipital furrow strong. Occipital segment of even width and equal to that of the frontal limb, slightly curved posteriorly. Anterior margin strongly concave, smoothly rounded anteriorly, same width as frontal limb. Free cheek relatively large, palpebral lobe raised and very prominent, antero-lateral margin strongly concave and wide, gradually diminishes in width and prominence into a narrow brim in the postero-lateral region where it terminates in a short stout genal spine. Area of genal spine is separated from remainder of free cheek by a broad shallow furrow which curves antero-laterally from the facial suture just posterior to the palpebral lobe.

Thorax: Only two incomplete specimens known. These consist of six and nine incomplete pleural segments of the "plévre á sillon" type, which are flattened at the lateral ends to form a margin. Rachis strongly arched, axial furrows deeply incised, total number of segments unknown.

Pygidium: A caudal shield consisting of five segments which become less strongly marked posteriorly; ratio of length to breadth 0.666. Axial lobe strongly convex, sub-conical, terminates abruptly posteriorly at the broad posterior margin; ratio of length to anterior width 1.3. Pleural lobes inferior to axial lobe. All sharply separated from margin by a faint furrow. Margin evenly rounded, slightly convex, ratio of width in axial region to length of caudal shield 0.333.

Remarks: Some specimens have been collected which have the frontal brim slightly wider than observed in the types.

Types: Holotype Y. P. M. 17166, M. S. M. locality 72.50
Paratype Y. P. M. 17167, M. S. M. locality 72.50
Paratype Y. P. M. 17168, M. S. M. locality 72.50
Paratype Y. P. M. 17169, M. S. M. locality 72.53
Paratype U. S. N. M. Ulrich's locality 101s
Paratype U. S. N. M. Ulrich's locality 101s
Paratype M. S. M. 7166, M. S. M. locality 72.50
Paratype M. S. M. 7180, M. S. M. locality 105.25

Occurrence: Middle and upper Rich Fountain formation, above the School Mine ledge.

JEFFERSONIA GRANOSA[8]

Cullison n. sp.

Plate XXXIV, figures 17-22

Description: Cephalon: represented by only the cranidium, free cheeks separated and uncertain. Glabella: subrectangular; ratio of length to width measured on the line between the palpebral lobes, average of holotype and two paratypes, 1.5; surface of glabella marked by one pair of strong, short, posteriorly directed glabellar furrows slightly posterior to mid-length and a very faint pair slightly anterior to the same point; glabella strongly arched transversely, separated from remainder of cranidium by strong longitudinal furrows which curve evenly around and join at the anterior end, posterior boundary marked by strong occipital furrow. Occipital segment of uniform width, convex upward, slightly arched posteriorly. Fixed cheek: medium size; palpebral area high; outer edge marked by a high, strongly developed brim. Facial sutures directed slightly out-

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8. Species name coined by E. O. Ulrich.

ward from axial line anteriorly where they cut directly across anterior margin. Frontal limb narrowest at axial line. Anterior margin a narrow, rounded ridge, slightly thickened toward axis, almost straight along a line normal to axial plane.

Granulose surface of cranidium best developed in central part of glabella.

Thorax: Unknown.

Pygidium: An elongate semicircular caudal shield composed of five segments; ratio of length to width, 0.7. Axial lobe strongly convex, conical, anterior four segments each bearing a short axial spine; surface of posterior end rounded steeply into posterior margin; ratio of length to anterior width, 1.8. Pleural lobes strongly arched. Pleural ribs separated by strong furrows which terminate abruptly at the margin. Margin relatively narrow, characterized by having strong doublure below and being bent downward at the posterior end where it is the widest.

Types: Holotype U. S. N. M. Ulrich's locality 101s
Paratype U. S. N. M. Ulrich's locality 101s
Paratype U. S. N. M. Ulrich's locality 238c
Paratype Y. P. M. 17171, M. S. M. locality 72.50
Paratype Y. P. M. 17172, M. S. M. locality 72.46
Paratype M. S. M. 7167, M. S. M. locality 72.46
Paratype M. S. M. 7168, M. S. M. locality 72.46
Paratype M. S. M. 7169, M. S. M. locality 72.50

Occurrence: Rich Fountain formation above the School Mine ledge.

JEFFERSONIA PRODUCTA[9]

Cullison n. sp.
Plate XXXIV, figures 1-9

Description: Cephalon: consists of cranidium and free cheeks rarely if ever found attached.

Glabella: Subrectangular narrowing very slightly anteriorly where it is uniformly rounded; ratio of length to width at palpebral lobes, 1.47; glabellar furrows absent but a pair of small elongated shallow depressions, directed slightly posteriorly, rise from the axial furrows slightly posterior to a line drawn between the center of the eyes. Glabella strongly arched transversely, less convex longitudinally. Occipital furrow strong, curves slightly posteriorly. Occipital segment of equal width throughout and bears a prominent axial low node or spine. Fixed cheek medium in size. Area in vicinity of palpebral lobes very high, slopes steeply away in both anterior and posterior directions. Around the region of the eye there is a fairly wide concave brim. The lateral margins of the fixed cheeks are directed outward anteriorly at an angle of approximately 30 degrees to the axial line. Frontal limb slightly convex, narrowest at axial line and widens laterally. Anterior margin a thickened rim slightly convex and upturned which apexes at the axial line; ratio of width of anterior margin to width of frontal limb in the axial plane, 1.5. Free cheek large. Palpebral lobe high, strongly convex, antero-lateral margin a thickened rim which gradually grows less prominent towards the postero-lateral region where it terminates in a short, thick genal spine.

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9. Specific name coined by E. O. Ulrich.

Thorax: None known.

Pygidium: A caudal shield composed of five segments, maximum width anterior; ratio of length to width, .83. Axial lobe very convex, conical, distinctly outlined by sharp axial furrows; posterior end rounded into the posterior margin; segments distinct, each of the anterior four segments bears a short tubercle at the axial line. Pleural lobes convex, sharply delineated at the lateral margins. Margin, medium width, flat to slightly concave, smooth. Surface of this species smooth.

Remarks: This species differs from *J. granosa* in that its surface is smooth. It differs from *J. missouriensis* in having an occipital spine, a concave posterior margin and axial spines on the pygidium and a thicker, narrower anterior margin on the cranidium.

Types:	Holotype U. S. N. M.	Ulrich's locality 238c
	Paratype U. S. N. M.	Ulrich's locality 238c
	Paratype U. S. N. M.	Ulrich's locality 238c
	Paratype U. S. N. M.	Ulrich's locality 238c
	Paratype U. S. N. M.	Ulrich's locality 101y
	Paratype U. S. N. M.	Ulrich's locality near Rolla, Missouri
	Paratype Y. P. M. 17163,	M. S. M. locality 72.50
	Paratype Y. P. M. 17165,	M. S. M. locality 72.50
	Paratype Y. P. M. 17164,	M. S. M. locality 67.2
	Paratype M. S. M. 7170,	M. S. M. locality 72.50
	Paratype M. S. M. 7171,	M. S. M. locality 72.50
	Paratype M. S. M. 7172,	M. S. M. locality 72.50
	Paratype M. S. M. 7264,	M. S. M. locality 72.50

Occurrence: Rich Fountain formation from "cotton rock" just above the School Mine ledge.

JEFFERSONIA MEDIACRISTA

Cullison n. sp.

Plate XXXIV, figures 25-27

Description: Cephalon: semicircular composed of cranidium and free cheeks, the latter rarely present. Cranidium: Glabella subrectangular, convexly arched, with a faint median longitudinal ridge, smoothly rounded anteriorly; lateral and circumglabellar furrows medium to strong. Glabellar furrows; two pairs, shallow, directed posteriorly; anterior pair anterior to eye, posterior pair central to eye. Fixed cheeks narrow, palpebral area relatively large, low, located posterior to center. Frontal limb straight to slightly convex, narrow at center, broadens laterally. Facial suture extends directly forward from the eye almost to anterior margin where it curves toward axis as it intersects margin. Anterior margin a narrow thickened ridge which tapers laterally. Occipital ring smooth and of even width.

Thorax: Unknown.

Pygidium: A caudal shield elongate semicircular, composed of five segments, strongly convex. Axial lobe relatively low, terminates at margin. Pleural lobes convex, ribs become less distinct posteriorly. Posterior margin smooth, steep, smoothly rounded posteriorly.

Remarks: The anterior margin and glabella furrows of this species resemble *J. granosa,* but the general proportions and palpebral lobe resemble *J. missouriensis.* The pygidium appears as a compromise of these two species. *J. mediacrista* is relatively small.

Types: Holotype U. S. N. M. Ulrich's locality 273d
Paratype U. S. N. M. Ulrich's locality 273d
Paratype Y. P. M. 17173, M. S. M. locality 75.23
Paratype M. S. M. 7253, M. S. M. locality 75.23

Occurrence: Rich Fountain formation.

JEFFERSONIA DELICATULA

Cullison n. sp.
Plate XXXIV, figures 30-32

Description: Cephalon: glabella subrectangular, strongly convex, anterior lobe inflated, two pairs of fairly strong, short posteriorly directed glabella furrows; anterior pair at anterior end of eye, posterior pair central to the eye. Area of palpebral lobe high, bounded laterally by well defined brim. Frontal limb narrow. Anterior margin a thickened ridge which apexes at center. Occipital furrow strong and as wide as occipital segment. Free cheek unknown.

Thorax: Unknown.

Pygidium: A caudal shield similar to *J. granosa* but narrower; the axial lobe is more convex but also bears centrally located spines on each segment. Posterior margin flat, narrow, not crossed by pleural furrows and is not bent downward at the posterior extremity as is *J. granosa.*

Types: Holotype U. S. N. M. Ulrich's locality 363s
Paratype U. S. N. M. Ulrich's locality 363s

Occurrence: Upper part of Rich Fountain formation.

JEFFERSONIA CRASSIMARGINATA

Cullison n. sp.
Plate XXXV, figures 13-16

Description: Cephalon: glabella subrectangular, makes up greatest portion of cranidium, smooth, medium convex, bounded by strong furrows, but bears no glabella furrows. Occipital furrow strong. Occipital segment broad. Fixed cheek; palpebral region slightly raised. Facial suture, cuts posterior margin about midway between axis and genal angle, anteriorly it is directed outward and forward from the eye to the anterior margin. Frontal limb narrow. Frontal margin a solid, semicircular ridge, thickened at center. Free cheek separated by a shallow furrow into two areas: a solid, heavy, rounded marginal area which terminates in the genal spine; and an inflated semicircular lobe which lies beneath the raised palpebral lobe.

Thorax: Unknown.

Pygidium: A solid, strongly convex, caudal shield approximately semicircular in outline. Axial lobe: maximum width ¼ width of pygidium; convex, conical, bearing three well marked segments anteriorly. Posterior end of axial lobe unsegmented, terminates abruptly in the anterior border. Axial furrows strong. Pleural lobes convex bearing four discernible broad ribs. Pleural furrows strong, do not extend upon border. Posterior border slightly concave just below center, inclined at an angle of approximately 45 degrees to the horizontal, underlain by a broad, strongly developed doublure.

Types: Holotype Y. P. M. 17177, M. S. M. locality 106.11
Paratype Y. P. M. 17178, M. S. M. locality 105.18
Paratype Y. P. M. 17179, M. S. M. locality 105.18
Paratype U. S. N. M. M. S. M. locality 106.11
Paratype U. S. N. M. M. S. M. locality 106.11
Paratype U. S. N. M. M. S. M. locality 106.11
Paratype M. S. M. 7173, M. S. M. locality 106.11
Paratype M. S. M. 7174, M. S. M. locality 106.11
Paratype M. S. M. 7175, M. S. M. locality 105.18

Occurrence: Theodosia formation near the center of the Blackjack Knob member.

JEFFERSONIA JENNII[10]

Cullison n. sp.

Plate XXXV, figures 17-22

Description: Cephalon: incomplete. Cranidium: Glabella strongly convex, roughly rectangular, rounded and slightly produced anteriorly, ratio of length to width 1.38. Fixed cheeks, narrow, separated from glabella by deep, strong furrows. Eye areas high (almost as high as the glabella at this point), bordered by a narrow, depressed brim. Occipital furrow and segment straight and of uniform width. Occipital segment higher than posterior end of glabella. Frontal limb very narrow to absent immediately below the produced glabella. Frontal margin a thickened ridge, slants postero-laterally and apexes immediately in front and below the glabella. Free cheeks with a short postero-lateral genal spine and outer margin marked by a narrow thickened rim. Facial suture cuts the anterior margin directly anterior to the eye, and the posterior margin approximately half way between the genal angle and the axial furrow.

Thorax: Unknown.

Pygidium: A caudal shield; ratio of width to length in two paratypes, 1.1. Axial lobe strongly convex, bearing four well developed rings and a terminal bulb, tapers evenly to an obtusely rounded posterior end that drops away abruptly to the narrow border. Axial furrows narrow, incised, do not continue around end of axial lobe. Pleural lobes slightly inflated and bear three broad pleural ribs, the posterior one of which is triangular. Pleural furrows do not cross the narrow posterior lateral border.

Remarks: According to Bridge,[11] this species is very similar to a cast of the type of *Bathyurus timon* Billings (1865, p. 261). It differs from *B. timon* in the following respects: 1. The pygidium is longer; 2. The axial lobe bears five distinctly separated segments; 3. The surfaces observed suggest no tubercles; and 4. The pleural furrows appear to be narrower.

Types: Holotype Y. P. M. 17180, M. S. M. locality 75.28
Paratype Y. P. M. 17181, M. S. M. locality 75.28
Paratype U. S. N. M. M. S. M. locality 75.28

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[10] This species named in honor of C. M. Jenni of Festus, Missouri, who has assisted the author greatly.

[11] Oral communication.

Paratype U. S. N. M. M. S. M. locality 75.28
Paratype M. S. M. 7176, M. S. M. locality A5.1
Paratype M. S. M. 7177, M. S. M. locality A5.1
Paratype M. S. M. 7178, M. S. M. locality 75.28
Paratype M. S. M. 7179, M. S. M. locality 75.28

Occurrence: Lower Cotter dolomite.

JEFFERSONIA sp. 1

Plate XXXV, figures 9-10

Discussion: This species is represented in the collections by one pygidium. Until a cranidium definitely related to this is known, the writer deems it unwise to give the species a definite name.

Cephalon: Unknown.

Thorax: Unknown.

Pygidium: A caudal shield somewhat similar to *Jeffersonia missouriensis,* except the transverse section is slightly more convex and the margin flat or concave. Axial lobe, conical, sharply rounded posteriorly, and bears five segments. Axial furrows sharp and incised. Pleural lobes triangular, strongly convex, bear four segments, the posterior one of which is triangular. None of these extends upon the flat smoothly rounded margin which is not separated from the lobes by a furrow, but by an abrupt change in the surface slope.

Specimen: No type established. Described pygidium U. S. N. M. ——, Ulrich's locality 456z.

Occurrence: Theodosia formation.

JEFFERSONIA sp. 2

Plate XXXV, figures 7-8

Discussion: This species is represented in the collections by one pygidium. Until a cephalon or cranidium can be definitely associated with this pygidium, the writer believes it unwise to establish a specific name.

Cephalon: Unknown.

Thorax: Unknown.

Pygidium: A caudal shield of slightly elongate semicircular outline, strongly convex transversely at the anterior end. Axial lobe of medium transverse convexity; axial furrows incised and fade out posteriorly where the axial lobe touches the margin. Pleural lobes, low, bear five segments. The pleural grooves end abruptly where the slope of the pleural lobes reverse abruptly to form the slightly concave, broad, evenly rounded margin.

Specimen: No type established. Described pygidium U. S. N. M. ——, Ulrich's locality 438u.

Occurrence: Lower Theodosia or upper Rich Fountain formation, just beneath the building rock at Jefferson City, Missouri.

BOLBOCEPHALUS Whitfield (1890)

BOLBOCEPHALUS JEFFERSONENSIS

Cullison n. sp.

Plate XXXIV, figures 28-29

Description: Cranidium: incomplete. Glabella slightly expanded anteriorly, smooth, bears no furrows, strongly convex transversely and longitudinally. Occipital furrow wide; occipital segment relatively narrow. Circumglabellar furrow strong. Fixed cheeks narrow anteriorly, eye areas slightly raised. No node on fixed cheek posterior to eye.

Thorax: Unknown.

Pygidium: A caudal shield, semicircular to slightly wider than long. Axial lobe low, posterior end rounded to acutely rounded, bears three clearly defined segments. Axial furrows strong, extend completely around axial lobe. Pleural lobes low, bear four broad ribs, not differentiated from the broad margin. Margin smooth, not crossed by pleural furrows but its surface continues laterally the same curvature which is present on the surface of the pleural lobes without any interruption.

Remarks: This species differs from *B. st. clairi* in that the cranidium has no inflated node behind the eye and the surface of the pygidium slopes smoothly from the axial furrow to the margin without interruption.

Types: Holotype M. S. M. 7181, M. S. M. locality 72.50
Paratype M. S. M. 7182, M. S. M. locality 72.52
Paratype Y. P. M. 17174, M. S. M. locality 57.1

Occurrence: Lower Rich Fountain formation.

BOLBOCEPHALUS ST. CLAIRI

Cullison n. sp.

Plate XXXV, figures 27-31

Synopsis: Weller and St. Clair, Geology of Ste. Genevieve County, Missouri, Mo. Bur. Geol. and Mines, Vol. XXII, 2nd Ser., p. 90, 1928, *Bolbocephalus st. clair, nomen nudum.*

Discussion: The writer believes that, inasmuch as this name is in the literature, even though it was originally published as a *nomen nudum*, it should be retained. Consequently, the description and figures are given below. The material used is from the locality mentioned by Weller and St. Clair (1928) and was collected by Ulrich who apparently furnished the faunal list published by them under their discussion of the Powell formation.

Description: Cranidium very bulbose. Glabella: narrowest along a line between the posterior end of the eyes, from where it expands posteriorly and anteriorly; slightly produced and nasute anteriorly; smooth, bears no glabellar furrows; slightly convex transversely, strongly convex longitudinally. Circumglabellar furrow deep. Occipital furrow narrow. Occipital segment wide, relatively straight.

Fixed cheeks narrow, widen posterior to eyes where a slight inflation is noticeable. Facial sutures bound narrow rims around eyes, thence trend posterolaterally to where they cross the occipital ring just inside the genal angle, anteriorly they cross the margin almost in front of the glabella if they do not join there. Frontal limb narrow, slightly convex. Free cheeks high, inflated around eye; palpebral lobe high; margin a rolled edge which terminates anteriorly in a short genal spine.

Thorax: Unknown.

Pygidium: A caudal shield, almost semicircular in outline. Axial lobe low, convex, tapers to a rectangular posterior end, and bears four faint segments. Axial furrows sharp, extend around axial lobe. Pleural lobes bear four faint ribs, faintly convex, merge into lateral margin. Margin wide, bent abruptly downward, smooth, not crossed by pleural furrows.

Types: Holotype U. S. N. M. Ulrich's locality 379o
Paratype U. S. N. M. Ulrich's locality 397o
Paratype Y. P. M. 17190, M. S. M. locality 75.28
Paratype Y. P. M. 17191, M. S. M. locality 75.28
Paratype M. S. M. 7184, M. S. M. locality A5.1
Paratype M. S. M. 7183, M. S. M. locality A4.1

Occurrence: Cotter dolomite and lower Powell dolomite.

Genus **LUTESVILLIA**[12]

Cullison n. gen.

Generic diagnosis: This genus is proposed to include those lower Ordovician trilobites which have a broad oval cephalon, with only slight convexity both transversely and longitudinally. The frontal limb is dominantly concave up and is not defined anteriorly by a thickened margin. The pygidium a caudal shield is characterized by; a broad low axial subrectangular axial lobe, strongly ribbed pleural lobes, a low convex margin which bears either one or two postero-lateral spines.

Comparison: The cranidium of this genus is very similar to that of *Jeffersonia* but differs in having less convexity, a broader frontal limb, and a frontal brim which is less turned up and less distinct. The free cheeks are similar to those of *Jeffersonia*, but differ by being lower in the palpebral region.

The pygidium resembles that of *Jeffersonia missouriensis* except for the presence of a pair of postero-lateral spines which are a posterior extension of the margin.

Genotype: *Lutesvillia bispinosa.*

LUTESVILLIA BISPINOSA

Cullison n. sp.

Plate XXXV, figures 1-6

Description: Cephalon: broadly oval. Cranidium: Glabella roughly rectangular, bounded by a distinct circumglabellar furrow; ratio of length to maximum width, 1.33 (average of holotype and two paratypes); broadly rounded anteriorly, only slightly inflated. Occipital furrow narrow, distinct and straight. Occipital segment broad and of uniform width. Fixed cheek, of about medium width, expands anteriorly from palpebral lobe, which is of average size. Frontal limb slightly convex. Frontal margin slightly upturned and relatively broad, not distinctly separated from limb. Free cheek low, elongate, bears a long postero-lateral spine, which is separated from the main body by a shallow sulcus which rises at the slightly upturned margin below the eye and swings backward and inward to the facial suture anterior to the spine.

Pygidium: A caudal shield bears a posteriorly directed spine on each side. Axial lobe distinct, slightly convex, bears five distinct segments and possibly a sixth. Ratio of length to anterior width, 1.614 (average of holotype and two paratypes, 1.62). The axial furrows do not curve around the posterior end of the axial lobe but disappear on reaching the margin, whereas the axial lobe extends upon the margin. Pleural lobes bear three broad short ribs, the posterior one of which tends to extend upon the margin. Margin broad, gently convex, inflated in the region of the origin of the broad, thick postero-lateral spines. Posterior margin straight and transverse between the spines.

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[12] This name was coined by Ulrich and the type species is so labeled in the U. S. G. S. collections.

Types:	Holotype U. S. N. M.	Ulrich's locality 102k
	Paratype U. S. N. M.	Ulrich's locality 102k
	Paratype U. S. N. M.	Ulrich's locality 102k
	Paratype U. S. N. M.	Ulrich's locality 102k
	Paratype U. S. N. M.	Ulrich's locality 102k
	Paratype M. S. M. 7185,	M. S. M. locality 88.1

Occurrence: Lower and middle Theodosia formation.

Family **SOLENOPLEURIDAE** Angelin
HYSTRICURUS Raymond (1913)
HYSTRICURUS ABRUPTUS

Cullison n. sp.

Plate XXXIV, figures 45-49

Description: Cranidium very postulose except in furrows. Glabella, forms most of cranidium; sides parallel, broadly rounded anteriorly; strongly convex; slightly produced anteriorly; no furrows visible. Circumglabellar furrow strongly incised. Occipital furrow strong and straight. Fixed cheeks narrow, long, inflated. Frontal limb very convex and inflated. A narrow non-pustulose area shaped like a shallow "V" apexes at about midwidth in the center of the frontal limb. The wings of this "V" rise at the intersection of the facial sutures and the very obscure margin. Eyes small, located about midlength. Facial suture cuts posterior margin just inside of genal angle. Free cheeks uncertain.

Thorax: Unknown.

Pygidium: Rhombic in plan. Axial lobe strongly convex, anterior three segments distinct, posterior two indistinct. Pleural lobes bear four distinct ribs separated by wide furrows. Margin bent abruptly downward, bounded by a rounded rim well below the terminus of the axial lobe. Margin crossed by ridges which have the same locations as the pleural furrows would have if they continued across the margin.

Types:	Holotype U. S. N. M.	Locality M. S. M. 72.50
	Paratype U. S. N. M.	Locality M. S. M. 72.50
	Paratype Y. P. M. 17176,	Locality M. S. M. 72.50
	Paratype M. S. M. 7256,	Locality M. S. M. 72.50

Occurrence: Middle and upper part of the Rich Fountain formation.

Genus **ROLLIA**

Cullison n. gen.

Generic diagnosis: Glabella subquadrate, convex, bluntly rounded anteriorly, bears furrows and is twice as long as the width of the frontal limb. Fixed cheek long, narrow, separated from glabella by strong furrow. Palpebral lobes high, surrounded by a depressed brim. Facial sutures cut posterior margins just inside the genal angles, trend diagonally forward and inward to rear of eyes, then around eyes to directly in front of the eyes where they trend diagonally outward to cut the frontal margin. Frontal limb slightly convex and wide. Frontal margin a narrow rounded rim.

Free cheeks, thorax and pygidium unknown.

Discussion: This genus is proposed to include one species obtained from the middle of the Rich Fountain formation. It differs from *Hystricurus* by having a relatively shorter, less prominent furrow bearing glabella, a wider and flatter frontal limb, and larger pustulose palpebral lobes.

Genotype: *Rollia goodwini.*

ROLLIA GOODWINI[13]

Cullison n. sp.

Plate XXXIV, figures 33-35

Description: The cranidium is the only known part of this species. Glabella short, subquadrate, bluntly rounded anteriorly, convex, bears three pairs of faintly impressed furrows which do not cross the glabella. The anterior pair originate adjacent to the front of the eye, curve convexly anteriorly and disappear before reaching the crest of the glabella. Second pair originate opposite the center of the eye, curve anteriorly and disappear. Posterior pair short, straight. Unfurrowed crest of glabella bears a few pustules. Occipital furrow strong, widens at center. Occipital segment bears a blunt, centrally located tubercle and is wider than furrow. Fixed cheek narrow at eye, broadens anteriorly and posteriorly. Palpebral lobe of cranidium is bounded by a depressed brim and bears a few small sparsely distributed pustules. Frontal limb broad and wide, slightly convex, bears a few scattered pustules. Frontal margin, a slightly raised narrow ridge-like prominence.

Free cheeks, thorax and pygidium unknown.

Types: Holotype U. S. N. M. M. S. M. locality 72.46
Paratype Y. P. M. 17175, M. S. M. locality 57.1
Paratype M. S. M. 7186, M. S. M. locality 57.1

Occurrence: Chert from the "cotton rock" beds immediately above the School Mine ledge of the Rich Fountain formation.

Family Uncertain

Genus RANANASUS

Cullison n. gen.

Generic diagnosis: Cephalon consists of a large cranidium and two very small free cheeks. Cranidium is dominated by the very large rounded or subconical strongly nasute glabella which bears no furrows. Circumglabellar furrow although strong posteriorly is weak where it lies ventral and anterior to the glabella. Facial sutures lie in the axial furrows at points directly anterior to the eyes. Fixed cheek very narrow, eyes small and slightly posterior to the center. Occipital furrow strong but occipital segment very narrow.

Thorax: Unknown.

Pygidium: Semicircular, slightly depressed. Ratio of width to length as 9:7. Axial lobe depressed; anterior width one-third of greatest width, subrectangular,

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[13] Named for Mr. Reo Goodwin in appreciation of his interest and services as assistant preparator of this material.

five segments, evenly rounded posteriorly. Border smooth with well marked doublure.

Remarks: This genus is proposed to include two species which have been noted in only the Rich Fountain formation of Missouri.

Genotype: *Rananasus conicus* Cullison.

RANANASUS CONICUS

Cullison n. sp.

Plate XXXIV, figures 36-40

Description: Cranidium made up almost entirely of the glabella, which is quite produced and apexes anteriorly. Frontal limb below glabella, plane; frontal margin narrow and shorter than distance between the eyes. Circumglabellar furrow shallow, trends outward anteriorly from occipital furrow to in front of the eye where, after coinciding with the facial suture, it swings outward, downward, and then inward to below the frontal lobe. Occipital furrow strong. Occipital segment narrower than furrow and tapers laterally. Fixed cheek narrow. Eyes small, center posterior to midlength. Free cheek unknown. Facial sutures intersects occipital furrow barely inside genal angle, trends inward to behind eye, thence around eye to where it coincides with glabellar furrow just anterior to eye, thence directly forward and downward almost to the anterior margin where it swings inward diagonally across the margin.

Thorax: Unknown.

Pygidium: Semicircular, not strongly arched. Axial lobe divided into five segments, roughly rectangular, depressed anteriorly, about one-third greatest width, smoothly rounded posteriorly. Pleural lobes not strongly ribbed; only anterior two ribs obvious, ribs merge and disappear in broad convex border which is developed evenly around the pygidium. A strong, well developed doublure is apparent on exfoliated specimens.

Remarks: This species differs from *R. brevicephalus* in the taper more nasute character of the glabella and in its larger size.

Types: Holotype U. S. N. M. M. S. M. locality 72.38a
Paratype U. S. N. M M. S. M. locality 72.38a
Paratype U. S. N. M. M. S. M. locality 72.38a
Paratype Y. P. M. 17192, M. S. M. locality 72.38a
Paratype Y. P. M. 17193, M. S. M. locality 72.38a
Paratype M. S. M. 7187, M. S. M. locality 72.38a
Paratype M. S. M. 7188, M. S. M. locality 72.38a

Occurrence: Lower part of Rich Fountain formation above the School Mine ledge.

RANANASUS BREVICEPHALUS

Cullison n. sp.

Plate XXXIV, figures 41-44

Description: Cephalon: cranidium composed chiefly of glabella which is subrectangular, broadly rounded and only slightly produced anteriorly. Shallow circumglabellar furrow, which coincides with facial sutures at points anterior to eyes, and intersects axis in front and below the slightly produced glabella. Eyes small, approximately at midpoint. Occipital furrow strong. Occipital segment narrow. Fixed cheek narrow. Free cheek unknown.

Thorax: Unknown.

Pygidium: Like that of *R. conicus* except smaller and more distinctly segmented.

Types: Holotype U. S. N. M. M. S. M. locality 106.2
Paratype M. S. M. 7189, M. S. M. locality 75.23
Paratype M. S. M. 7190, M. S. M. locality 72.50

Occurrence: Lower Rich Fountain formation from just above School Mine ledge.

Family Uncertain

Genus **GONIOTELUS** Ulrich (1927)

Genotype: *Bathyurus perspicator* Billings (1865, p. 205). This is *Goniurus perspicator* (Billings) as proposed by Raymond (1913). Ulrich (1927, p. 14) replaced the name *Goniurus* with Goniotelus because the former was preoccupied.

Goniotelus, Ulrich (*Goniurus*, Raymond) as defined by Raymond (1913, p. 65):

> "Facial suture as in *Bathyurus*, except that the fixed cheek extends a little farther toward the genal angle. Eyes very long, narrow, and close to the glabella. Glabella long, reaching almost to the frontal margin, tapering rapidly in front of the eyes. Neck furrow sharp extending across fixed cheeks and free cheeks. Genal angles with short sharp spines. A narrow, elevated rim extends around the whole cephalon, and the cephalon is slightly nasute in front. Pygidium convex, triangular, with a long terminal spine."

GONIOTELUS MARIONENSIS

Cullison n. sp.

Plate XXXV, figures 32-37

Description: Cephalon: no complete cephalon known. Cranidium composed chiefly of the glabella. Glabella, convex, subrectangular, bounded by marked circumglabellar furrow, broadly rounded and low anteriorly. Occipital furrow deep, extending on to fixed cheeks. Cheeks narrow, elongate. Palpebral lobes large, located slightly posterior to center and bounded by a depressed margin. Frontal limb narrow. Frontal margin a thickened, narrow, transverse ridge. Free cheeks uncertain. Entire surface covered with fairly large tubercles of almost uniform size.

Thorax: Only known specimen incomplete. Axial lobe strongly convex. Pleural lobes convex. Eight thorasic segments observed. These are strongly developed at the axial lobe, and bear a pleural groove on the pleural lobes, terminal ends flattened and slightly expanded into a narrow border.

Pygidium: Triangular. Axial lobe, convex, evenly tapered, conical, bears three well defined segments anteriorly which appear to have three transverse rows of tubercles each; posterior segments fused and slightly buttressed against the tail spine by a low ridge which crosses the posterior margin. Pleural lobes convex, bear four ribs, the posterior one almost fused with the third rib, terminate abruptly at the margin. Margin wide, inclined, slightly convex, crossed by the tail spine buttress which is axial. This causes the terminal spine which is of medium length to have a triangular cross section near its base although it becomes round at its apex.

Types: Holotype U. S. N. M. Ulrich's locality 101k
Paratype U. S. N. M. Ulrich's locality 101k
Paratype U. S. N. M. Ulrich's locality 474q
Paratype Y. P. M. 17194, M. S. M. locality A5.1
Paratype Y. P. M. 17195, M. S. M. locality A4.8
Paratype M. S. M. 7192, M. S. M. locality A4.8
Paratype M. S. M. 7193, M. S. M. locality A4.8
Paratype M. S. M. 7194, M. S. M. locality A4.9

Occurrence: "Black Ledge" of the Powell dolomite 40 to 50 feet above the base.

GONIOTELUS SEMICIRCULARIS

Cullison n. sp.

Plate XXXV, figures 25-26

Description: Pygidium: an elongate, triangular, caudal shield which terminates in a heavy, short spine of semicircular cross section. The flat side of this spine is ventral. Axial lobe narrow, strongly convex, bearing at least three segments, bounded by strong axial furrows which unite at the posterior end. Pleural lobes convex, elongate-triangular in plan and bear one broad rib. Pleural furrows do not extend on to lateral margin. Margins broad, slightly convex, broadening posteriorly where they very gradually merge into the thick caudal spine.

Comparison: This species represents the nearest approach to *Goniotelus* (*Bathyurus*) *caudatus* (Billings) (1865, p. 261) that the writer has seen. This species differs from *G. marionensis* in that the terminal spine is more of an extension of the lateral margins than an accessory spine. The pygidium is more elongate. The terminal spine is semicircular in cross section rather than triangular and is not buttressed against the end of the axial lobe.

Remarks: This species is represented by three incomplete, poorly preserved pygidia, which normally should not be described until better specimens are available. However, their occurrence in the lower part of the Cotter at its type locality gives them stratigraphic significance which may be of use in later work.

Types: Holotype Y. P. M. 17182, M. S. M. locality A4.1
Paratype M. S. M. 7195, M. S. M. locality A4.1

Occurrence: Lower Cotter dolomite.

GENUS (?) sp. (?)

Plate XXXV, figures 23-24

Discussion: This unknown form is represented by an incomplete pygidium. If it were not so different than the trilobites normally found in this zone, it would not be mentioned. However, the writer believes that continued work in these beds will result in the discovery of more complete specimens and at that time a complete classification and description of this form will be given.

Cephalon: Unknown.

Thorax: Unknown.

Pygidium: One complete caudal shield, differing from any heretofore observed in beds of lower Ordovician age. Axial lobe; strongly convex transversely, tapers slightly anteriorly where it is broadly rounded, bears five sharply separated segments. Pleural lobes low, bear at least four, possibly five, distinctly separated segments. Pleural grooves appear to extend to the boundary with little if any marginal area. Posterior area slightly inflated and terminates in a straight transverse boundary which curves laterally. Surface entirely covered by pustules of different sizes.

Specimen: No type established. Described specimen M. S. M. 7258, M. S. M. locality 106.11.

Occurrence: Middle Theodosia formation.

LIST OF MISSOURI SCHOOL OF MINES AND METALLURGY FAUNAL LOCALITIES

(*Locality of a described specimen)

Missouri Counties

Callaway County No. 41

41.7—In the west facing bluff below sandstone, in a cherty conglomerate, near the center of sec. 13, T44N, R11W. *Leseurilla* zone of Lutie member of Theodosia formation.

Cole County No. 57

57.1*—At the base of the hill on the north side of the Moreau River and on the east side of U. S. Highway 63 in residual chert in the SW ¼ SW¼, sec. 27, T44N, R11W. *Jeffersonia* trilobite zone of Rich Fountain formation.

Osage County No. 58

58.1—On old Highway 63 on hill south of Maries River, just south and east of Westphalia about 80 feet above river on second bench north of the house at the road fork. *Jeffersonia* zone of Rich Fountain formation.

58.3*—On Osage County Highway "E" in the SE cor., NW ¼, sec. 15, T42N, R9W. *Ozarkocoelia* zone in the top of the School Mine ledge on south side of road below house.

58.4—In the center of sec. 15, T42N, R9W on Osage County Highway "E" in residual chert on south side of road. *Jeffersonia* trilobite zone of the Rich Fountain formation.

58.5—On Osage County Highway "E", just north of the center of sec. 16, T42N, R9W, from residual chert on both sides of the road. Lower Theodosia fauna in chert.

58.6—NW ¼ SW ¼, sec. 24, T43N, R10W, elevation 650 feet, on private road down to farm house. *Jeffersonia* trilobite zone of the Rich Fountain formation.

58.7—Above and to the east of U. S. Highway 63 at elevation 900 feet plus, in the angle between highway and county road, about 3 miles north of Freeburg in the NW cor., NE ¼ NE ¼, sec. 28, T42N, R9W. Lower Theodosia formation.

58.8—SE cor. SE ¼ SE ¼ SE ¼, sec. 36, T44N, R10W, elevation about 780 feet, in granular dolomite on both sides of U. S. Highway 50 at top of hill just west of junction with county road. Lower Theodosia formation.

58.9—NW ¼ NE ¼, sec. 3, T41N, R9W, in massive dolomite just below conglomeratic sandstone, on east side of Highway 63. Lower Theodosia formation.

Maries County No. 67

67.1—2.2 miles south of Osage-Maries County line on U. S. Highway 63 temporary, at point where road runs approximately east-west in about sec. 22, T41N, R9W, from residual chert on both sides of the road. Lower Rich Fountain *Jeffersonia* trilobite zone.

67.2*—In the center of the north line, SE ¼ SW ¼, sec. 27, T39N, R8W, from residual chert in the saddle on the north side of the road just east of the road fork. Middle Rich Fountain formation.

67.3—On road near the center of the south line, sec. 28, T39N, R8W. *Jeffersonia* zone of the Rich Fountain formation.

Phelps County No. 72

72.29—Meramec Springs quadrangle. In extreme NW corner of quadrangle, 100 yards north of SW cor., sec. 19, T38N, R7W, along secondary road on hillside, 50 to 60 feet above house. Lower Rich Fountain formation.

72.38*—Meramec Springs quadrangle. Along slope above road at corner, elevation 1053 feet, and south on side road. Three horizons: (a) at elevation 1035 feet; (b) at elevation 1043 feet; (c) at elevation 1048 feet. Fossils in chert. Location E ½ SE ¼ SE¼ SW ¼, sec. 21, T37N, R7W. *Jeffersonia* zone, and higher beds Rich Fountain formation.

72.42*—Rolla quadrangle. On U. S. Highway 63 at its crest over Pilot Knob, east side of road, elevation 1180 feet, in chert and dolomite. In the NW cor., SE ¼ NW ¼, sec. 27, T36N, R8W. Middle Rich Fountain formation.

72.43—On Highway 63 above School Mine ledge at elevation 1060 feet, SW ¼ SW ¼, sec. 26, T37N, R8W. On north and east side of highway. *Jeffersonia* zone of Rich Fountain formation.

72.46*—NE ¼ SE ¼, sec. 33, T38N, R8W, in north bank of ditch east of house, at elevation 1000 feet. *Jeffersonia* zone of Rich Fountain formation.

72.49*—Rolla quadrangle. NW cor., SE¼ NW ¼, sec. 3, T37N, R8W, at elevation 1140 feet on SE side of hill top on old road. Residual chert masses. *Ceratopia torta* zone. Theodosia formation.

72.50*—Rolla quadrangle. E ½ E ½ SW ¼, sec. 3, T37N, R8W, at elevation 1020 feet, from residual chert nodules. *Jeffersonia* zone of Rich Fountain formation.

72.51*—Rolla quadrangle. SE cor., SW ¼ SW ¼, sec. 3, T37N, R8W, elevation 980, from residual chert nodules. A cephalapod locality in the *Jeffersonia* zone of the Rich Fountain formation.

72.53*—SE cor., SW ¼ SW ¼, sec. 10, T37N, R8W, at elevation 1000 feet. Residual chert and chert in place in the immediate vicinity of the Missouri School of Mines and Metallurgy Experimental Mine. Lower Rich Fountain formation.

Jefferson County No. 75

75.19—E ½, E ½, S ½ of the 2 miles north and south sec. 6, T39N, R6E, on the east side of road approximately ½ way up the hill and 42 feet above sandstone layer. Lower Cotter (?) *Ceratopea tennesseensis* zone.

75.22*—SW ¼, NW ¼, sec. 18, T39N, R6E, on east side of road 40 feet above upper Roubidoux sandstone in residual chert, *Jeffersonia* zone of lower Rich Fountain formation.

75.23*—W ½, SE ¼, sec. 18, T39N, R6E, at elevation 620 feet, approximately 44 feet above top of Roubidoux, *Jeffersonia, Ozarkocoelia,* and *Ceratopea capuliformis* zone, lower Rich Fountain formation.

75.26—SW ¼, SW ¼, SE ¼, sec. 17, T39N, R6E, elevation 510 feet plus, at top of School Mine ledge, *Jeffersonia* zone, lower Rich Fountain formation.

75.28*—SW ¼, sec. 27, T40N, R6E, road from Missouri State Highway 25 down to Crystal City Glass Workers Country Club. In massive, gray granular, dolomite on north side of road, *Jeffersonia jennii* and *Campbelloceras simplex* zone of lower Cotter.

Wright County No. 88

88.1*—SE ¼, NE ¼, sec. 14, T28N, R16W, on NW side of U. S. Highway 60 in residual cherts, Theodosia formation, *Lutesvillia bispinosa* zone.

88.2—Two miles south of Hartville on east side of Missouri Highway 5 in road ditch, fossils collected from residual cherts, Rich Fountain formation. *Jeffersonia* and *Ceratopea capuliformis* zone.

Bollinger County No. 92

92.8—On Missouri State Highway 51, 0.45 mile north of junction with Highway 54 in a little gully east of cut, fossils from residual chert, *Lutesvillia bispinosa* zone, Theodosia formation.

Christian County No. 95

95.5—On Missouri Highway 125 between .5 and .75 mile north of Garrison in the SE ¼ of sec. 21. T25N, R19W, on west side of road in heavy residual chert, lower Theodosia formation.

Barry County No. 103

103.2—Center of W ½, sec. 2, T21N, R25W, elevation 1000 feet, south of road junction, lower Theodosia formation, *Ceratopea torta* zone.

Taney County No. 105

105.2—Center of SE ¼, sec. 12, T23N, R21W, on west side of Missouri State Highway 76A, at Rockaway Beach. Lower Theodosia formation.

105.3—Center of SE ¼, sec. 12, T23N, R21W, on west side of Missouri State Highway 76A at Rockaway Beach. 135 feet to 150 feet above lake level, fossils in residual chert, lower Theodosia formation, *Ceratopea torta* zone.

105.4*—Center of SE ¼, sec. 12, T23N, R21W, on west side of Missouri State Highway 76A at Rockaway Beach. 160 feet to 170 feet above lake level, fossils in residual chert, lower Theodosia formation.

105.16*—On Missouri State Highway 80, east of Big Creek, at elevation 900 feet, SE ¼, NE ¼, sec. 24, T22N, R17W, from chert on west side of road. *Tritoechia* cf. *delicatula* and *Tritoechia typica* zones, lower Blackjack Knob Member of the upper Theodosia formation.

105.17*—On Missouri State Highway 80, east of Big Creek, at elevation 800 feet, NE ¼, NE ¼, sec. 24, T22N, R17W, in "Black and White" chert bed, *Shumardoceras complanata, Hormotoma lutiensis* zone of the lower Theodosia formation.

105.18*—On Missouri State Highway 80 at junction with old road, elevation 920 feet, in SW cor., NE ¼, SE ¼, sec. 14, T22N, R17W. *Tritoechia typica* and *Leseurilla planodorsalis* zone in the middle Theodosia formation.

105.19—On Missouri State Highway 80, west side of Blackjack Knob, in the SW ¼, NE ¼, sec. 16, T22N, R17W, at about 1175 feet elevation, north side of road in drain obtained from dolomite in place. Lower Cotter formation.

105.20*—On approximately the north line of Sec. 16 in the NE ¼, NE ¼, sec. 16, T22N, R17W. On road north of Blackjack Knob, elevation 1003 feet, middle of Blackjack Knob member of the Theodosia formation.

105.22—Just northwest and below house near the center of S ½, NE ¼, sec. 24, T22N, R17W. Elevation 930 feet, residual chert, lower Blackjack Knob member of the Theodosia formation.

105.23—About 100 yards west of point where W.P.A. road joins Missouri State Highway 76, approximately in the NE ¼, SW ¼, sec. 20, T24N, R20W. Elevation 909 feet, silicified specimen in residual chert, middle Theodosia formation.

105.24*—On Missouri State Highway 76, about 1 mile west of bridge over Swan Creek at road side picnic ground on north side of road, NE cor. of SW ¼, sec. 22, T24N, R20W. Lutie member of Theodosia formation.

105.25*—At the ford of Missouri State Highway 80 over Big Creek, a float boulder specimen of *Jeffersonia missouriensis* derived from up the creek. Age of specimen, Rich Fountain.

Ozark County No. 106

106.2*—On Missouri State Highway 80, 0.25 mile west of Tecumseh bridge over north fork of White River, fossils collected from NE ¼, SW ¼, sec. 16, T22N, R12W, *Ceratopea capuliformis* and *Jeffersonia* zone, lower Rich Fountain formation.

106.4*—On the road south of Dawt, 180 to 190 feet above North Fork White River in the SE ¼, SE ¼, sec. 3, T22N, R12W, from residual chert approximately in place, *Jeffersonia* zone of lower Rich Fountain formation.

106.5—Near the top of hill on east side, Missouri State Highway 8, in the NW ¼, NW ¼, sec. 8, T22N, R13W. *Orospira bigranosa* zone in residual chert about 125 to 135 feet above highway. Middle Theodosia formation.

106.6*—From chert in place on north side of county road in SW ¼, SE ¼, NW ¼, sec. 32, T22N, R13W. Middle Theodosia formation.

106.7*—Thornfield quadrangle, SW ¼, SW ¼, sec. 18, T22N, R15W, near top of the hill west of Theodosia, east of Lutie. Elevation 860 feet, from residual chert, *Ceratopea jonesi* and *Orospira gainesvillensis* zone. Blackjack Knob member of Theodosia formation.

106.8*—Just east of house, elevation 830 feet, center of SE ¼, SE ¼, sec. 6, T21N, R14W, in dolomite, sandstone, and residual chert. *Orospira gainesvillensis* zone, middle Theodosia formation.

106.11*—On the Isabella-Hammond road about 1 mile north of Isabella and just north of bench mark in the SE cor., NE ¼, NE ¼, sec. 16, T22N, R15W, in residual chert blocks along road. *Leseurilla isabellaensis* and *Orospira elegantula* zone of Blackjack Knob member of Theodosia formation.

106.12—Isabella-Pontiac road, elevation 800 feet, on the hill north of Spring Creek crossing, NW ¼, sec. 3, T21N, R15W in residual chert blocks. Middle Lutie member of Theodosia formation. This is near the type locality of *Orospira bigranosa* as described by Shumard.

106.13—On Missouri State Highway 80 and Missouri State Highway 5, SW cor., SE¼, NE ¼, sec. 12, T22N, R14W in chert float on both sides of road. Lower part of Blackjack Knob member of Theodosia formation.

106.15—Just west of center of sec. 33, T22N, R14W, at approximate elevation of 1100 feet in residual chert in road cut on south side of Pontiac W.P.A. road, lower Cotter formation.

106.16*—Missouri State Highway 95, ½ mile south of Thornfield, north of borrow pit on west side of road 40 to 50 feet above Little North Fork River in NW cor., SE¼, NW ¼, sec. 1, T23N, R16W, *Jeffersonia, Archaeoscyphia annulata* zone. Lower Rich Fountain formation.

106.22—Near Zanoni on W.P.A. road west of Pine Creek, elevation 840 to 850 feet, NE ¼, sec. 12, T23N, R13W, on southeast side of road, *Jeffersonia, Ozarkocoelia* zone of Rich Fountain formation.

106.24 A and 106.24 B—In NE cor., NW ¼, SE ¼, sec. 29, T22N, R15W, on hill slope, just west of Theodosia school, *Orospira bigranosa* zone and *Hormotoma lutiensis* zone. Both represented.

106.24—On Theodosia-Hammond road, elevation 800 feet in SE corner, NW ¼, NE ¼, sec. 18, T22N, R15W, "Black and White" chert bed, *Hormotoma lutiensis* zone.

106.26—From chert float along both sides of county road at elevation 880 feet ±, in the N ½ of SE ¼, NW ¼, sec. 32, T23N, R15W, lower Theodosia formation.

106.28—On west side of Missouri State Highway 95, 100 yards south of bridge over Little North Fork at elevation 820 feet in the NW ¼, SE ¼, NE ¼, sec. 1, T23N, R15W. *Archaeoscyphia annulata* zone of lower Rich Fountain formation.

Arkansas Counties

Carroll County No. A2

A2.1*—Where the Golden, Missouri-Grand View, Arkansas road comes close to Kings River in the NW ¼, sec. 26, T21N, R25W, just south of road fork to Summer's ford. Fossils from residual chert, lower Theodosia (?).

Marion County No. A4

A4.1*—Just west of the approach to bridge over White River on U. S. Highway 62, in the SE cor., sec. 2, T19N, R15W. Fossils collected from drusy, red, porous, residual chert. Lower Cotter formation.

A4.2*—Center NE ¼, sec. 7, T19N, R15W, on east side of road in residual, red, porous, drusy chert at about an elevation of 675 feet. *Ceratopea jenkinensis* zone, upper Cotter formation.

A4.3—On Arkansas State Highway 101 in the W ½, W ½, W ½, sec. 35, T19N, R15W, on west side of road just above wet weather springs in porous, brown chert in place. Middle Cotter formation.

A4.4—NW ¼, NW ¼, sec. 35, T19N, R15W, porous, brown, drusy, chert from both sides of road, approximately 40 feet above base of Powell, "Black ledge" of Powell dolomite.

A4.5—Southwest of Pace's ferry over White River, SE ¼, sec. 6, T20N, R15W, about 50 feet above road in residual chert. Lower Blackjack Knob member of the Theodosia formation.

A4.6*—On W.P.A. road in SE ¼, sec. 22, T19N, R15W. About 30 feet below "Y", elevation approximately 640 feet. Residual chert on west side of road. *Ceratopea jenkinensis* zone of Cotter dolomite.

A4.7*—SE ¼, sec. 14, T19N, R15W, elevation approximately 650 feet, on W.P.A. road in side ditch on the hill slope east of Fallen Ash Creek. *Ceratopea jenkinensis* zone of Cotter dolomite.

A4.9—Slightly north of center of east line, sec. 28, T19N, R16W. Fossils in long block of drusy, porous, red chert along side of road. "Black ledge" of Powell dolomite.

A4.10—Near center of sec. 29, T19N, R16W, from porous, drusy, red, residual chert, essentially in place. "Black ledge" of Powell dolomite.

A4.11—W ½, SW ¼, sec. 32, T19N, R16W, where U. S. Highway 62 curves around hill in a cut just above the railroad track. Fossils in residual chert of Powell dolomite. Also location of measured section 18, Plate XXIII, here designated as the type section.

A4.13—SE corner, NE ¼, SW ¼, sec. 31, T21N, R15W just above curve and on west side of Pontiac, Missouri-Oakland, Arkansas road. *Orospira* from chert in place. Lower Theodosia formation.

A4.14—On Pontiac-Oakland road just east of road fork, sec. 20, T21N, R15W, elevation 760 feet. Lower Blackjack Knob, *Leseurilla* zone of Theodosia formation.

A4.15—Along the Arkansas Highway 14, between Yellville and Cowan in approximately the E ½, E ½, sec. 16, T18N, R16W. Fossils in drusy, porous, red or brown, residual chert. "Black ledge" of Powell dolomite.

A4.16—Center of S ½, SE ¼, sec. 6, T19N, R15W, on north side of creek along old road. *Ceratopea jenkinensis* zone of upper Cotter dolomite.

A4.17—NW ¼, NE ¼, sec. 18, T20N, R15W, elevation 550 to 600 feet, at point where Oakland-Pace's Ferry W.P.A. road turns up the hill from the river flood plain. Gainesville sandstone and contained species of *Orospira*. Lower Blackjack Knob member of Theodosia formation.

A4.18—NW corner, NE ¼, sec. 27, T19N, R15W, in type section of the Cotter below Crooked Creek chert bed and above abandoned concrete culvert. Fossils in blue, brecciated chert, middle Cotter dolomite.

A4.19—SE ¼, NE ¼, sec. 31, T21N, R15W, on high point on bluff between junction of Little North Fork and Spring Creek. *Orospira gainesvillensis* and the associated forms in Gainesville sandstone bed. Middle Theodosia formation.

Baxter County No. A5

A5.1—E ½, NW ¼, sec. 31, T19N, R14W, on road down to ferry and fishing camp, at elevation approximately 500 feet. Fossils from porous, drusy, red to brown chert. *Jeffersonia jennii* zone of lower Cotter dolomite.

A5.2—SW corner, sec. 32, T19N, R14W, on south side of road just east of turn at elevation of approximately 500 feet, in red, porous chert. *Jeffersonia jennii* zone of Cotter dolomite.

A5.3—On W.P.A. road, north side of Howards Creek, 129 feet above the low water bridge near center of N ½, SW ¼, sec. 17, T20N, R14W. Upper *Ceratopea* and *Orospira* zone of Blackjack Knob member of Theodosia formation.

A5.5—East of Long Mountain on Oakland road in the NW ¼, NW ¼, sec. 29, T21N, R14W, in residual chert block on east side of road. Upper Cotter dolomite.

A5.6—In NW corner of Central rectangle at the top of the first high hill on W.P.A. road west of Tracey's ferry over North Fork of White River in large porous, drusy, red, residual chert boulders. "Black ledge" of Powell dolomite.

LIST OF ULRICH'S LOCALITIES

101k—Near Yellville, Arkansas.

101o—Swan Creek ¼ mile above mouth of Elkhorn Creek, Christian County, Missouri.

101p—About 1 mile N. of Isabella, Ozark Co., Missouri alongside of road from laminar and rotten chert with large gastropods. On road from Thornfield to Shumards from Johnson's house.

101s—9 miles south of Mansfield, Missouri.

101y—1 mile NW of Yount's store, Perry County, Missouri.

102k—On Possum Creek, 1 mile west of Lutesville, Bollinger County, Missouri.

238c—1 mile east of Buffalo, Missouri.

273d—1 mile east of Bryant's Fork, 2½ miles west of Train P. O. on road from Rockbridge to Dora, Ozark County, Missouri.

281b—4 miles south of Chadwick, Missouri.

363s—½ mile west of Cuba, Missouri.

397o—Cornwall Copper Mine, 8 miles SW of Ste. Genevieve, Ste. Genevieve County, Missouri.

438u—Just beneath the building rock at Jefferson City, Missouri.

456z—8 miles south of Chadwick and 1½ miles west of Garrison, Christian County, Missouri.

———Ulrich's locality near Rolla, Missouri.

474q—Ulrich's locality NE of Yellville, Arkansas.

EXPLANATION OF PLATES

CULLISON

PLATE XV

Section No. 1 State Mo County Osage

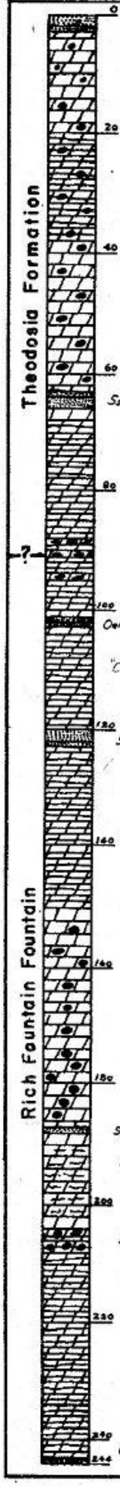
Quadrangle Linn

Units Present

1. Theodosia
2. Rich Fountain
3. Rubidoux
4.

T. 42 N R. 9 W.

Measured by J. S. C. Date 1941



Ss: Buff to Brown, Heavy Float

Dolomite:
Fine Grained, Argillaceous, Yellow to Buff
Thinly bedded "Cotton Rock"

Chert:
Nodular, Dense, Grey and Blue Banded

Entire section very much weathered

Ss: Buff to Red

Covered:
Probably "Cotton Rock."

Oolite: Silicious, Grey to Brown to Red, Quartzose

"Cotton Rock": Some irregular chert masses and lenses.

Ss: Thinly bedded, Red to Buff.

"Cotton Rock": Slightly Cherty.

Dolomite:
Grey to Buff, Medium grained, Interbedded with "Cotton Rock".

Chert:
Nodular, Grey to White, Massive
Fossiliferous.

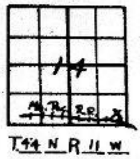
Ss: Coarse grained, Buff to Brown.

Dolomite:
Grey, Massive, Medium to Coarse grained, Weathering pitted. "School Mine Ledge"

Dolomite.
Grey to Buff, fine grained, Argillacious, Thin bedded, slightly Cherty.

Oolite: Silicious, Brown, Chert.
Top of Rubidoux.

Section No. 2 State Mo. County Cole



Quadrangle Jeff. City 30'

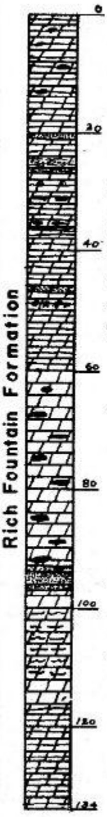
Units Present

1. Rich Fountain
2.
3.
4.

T. 44 N R 11 W

Measured by J. S. C. Date 1941

LIBRARY
FLORIDA STATE UNIVERSITY
TALLAHASSEE, FLORIDA



"Cotton Rock," Medium Bedded, Cherty.
Chert oolitic

Dol: Grey, Medium grained, Cherty, Slightly oolitic chert, Nodules, Arenaceous near center.

Dol: Yellow to Blue, Finegrained, Thinly bedded, Very argillaceous.

"Cotton Rock": Massive, Cherty.

Dol: Grey, Medium grained, Massive, Vitreous chert.

"Cotton Rock": Thinly bedded, Chert lentils.

Shale: Greenish grey, Cherty.

"Cotton Rock": Yellow to Buff.

Dol: Medium grained, Grey. Some "Cotton Rock" Arenaceous toward center.

Chert: Brecciated, Blue and Grey Banded

"Cotton Rock": Yellow to Buff, Massive.

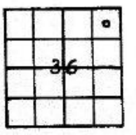
Dol: Fine to Medium grained, Grey, Massive, Containing large Grey Chert Lentils.

Ss. Dolomitic. Yellow to Brown, Cross bedded.
("Moreau Ss." of Winslow 1894)

Dol: Medium to Coarse grained, Grey Massive. "School Mine Ledge" Weathers to pitted surface

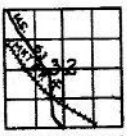
Level of Moreau River

Section No. 3 State Mo County Callaway
Quadrangle Jeff. City 30'
Units Present
1. Theodosia
2. Rich Fountain
3.
4.

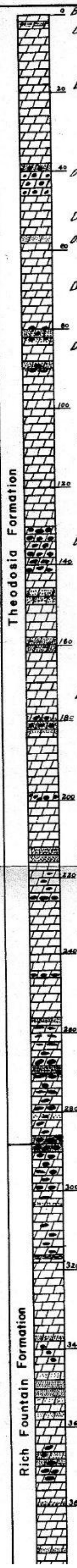


T. 45 N R. 11 W.
Measured by Mo.G.S. Well # 5585 Date ______

Section No. 4 State Mo. County Callaway
Quadrangle Jeff. City 30'
Units Present
1. Theodosia
2. Rich Fountain
3.
4.



T 45 N R 11 W
Measured by J. S. C. Date 1938



Base of The Devonian

Dol: "Cotton Rock", Arenacious and Argillacious

Dol: Grey to Buff, "Cotton Rock" with Bluish Opalescent Chert, and some Sand Grains

Dol: Grey to Buff, "Cotton Rock" Arenacious, Cherty, with some Pyrite

Dol: Grey to Buff

Dol: Arenacious

Dol: Grey to Buff, Slightly Cherty

Dol: Grey, Containing Dull White oolitic Chert and Ss. Lenses.

Dol: Grey to Buff, Argillacious, with much Oolitic Chert

Dol: Grey to Buff, Containing much White and Grey Chert

Dol: "Cotton Rock" with numerous Quite Sandy Beds, Some Shale Beds; Coarsely Crystalline Dol. near The Top, and numerous Oolitic Chert Beds.

Chert: Brown and Blue Oolitic Quartzose, Dolomitic.

Dol: Grey to Buff, Cherty, Shaly, slightly Sandy.

Dol: Grey to Buff, Sandy at the Top, Cherty below.

Dol: Cherty, Oolitic, Sandy

Dol: Grey to Buff, very Cherty, Sandy. Chert Conglomerate in Areas of Outcrop.

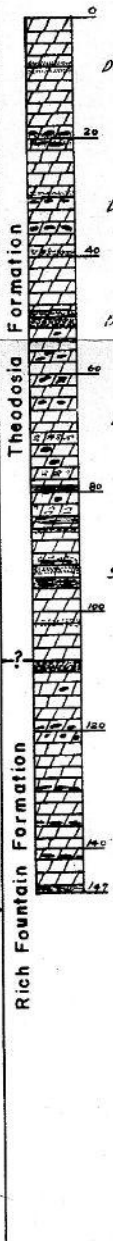
Dol: Grey to Buff, "Cotton Rock", Cherty, with Sand Lenses.

Dol: Grey, Crystalline, very Sandy and Cherty.

Dol: Grey, Crystalline, Cherty

Ss: Grey to Buff

Dol: Grey, Crystalline, Silicious, School of Mines Ledge.



Top of Quarry

Dol: "Cotton Rock", Slightly Cherty, Sandy near Center.

Dol: Grey to Buff, Coarsely Crystalline and fine Grained Oolitic, Cherty, with some Thin Shale Beds.

Dol: Silicious, Cherty, Blocky, Oolitic.

Dol: Grey to Buff, Fine Grained to Crystalline, with Chert layers and Nodules. Thin Shale Beds, and small Ss. Lentils.
Some Conglomeritic Chert Beds

Ss: Thin, Oolitic

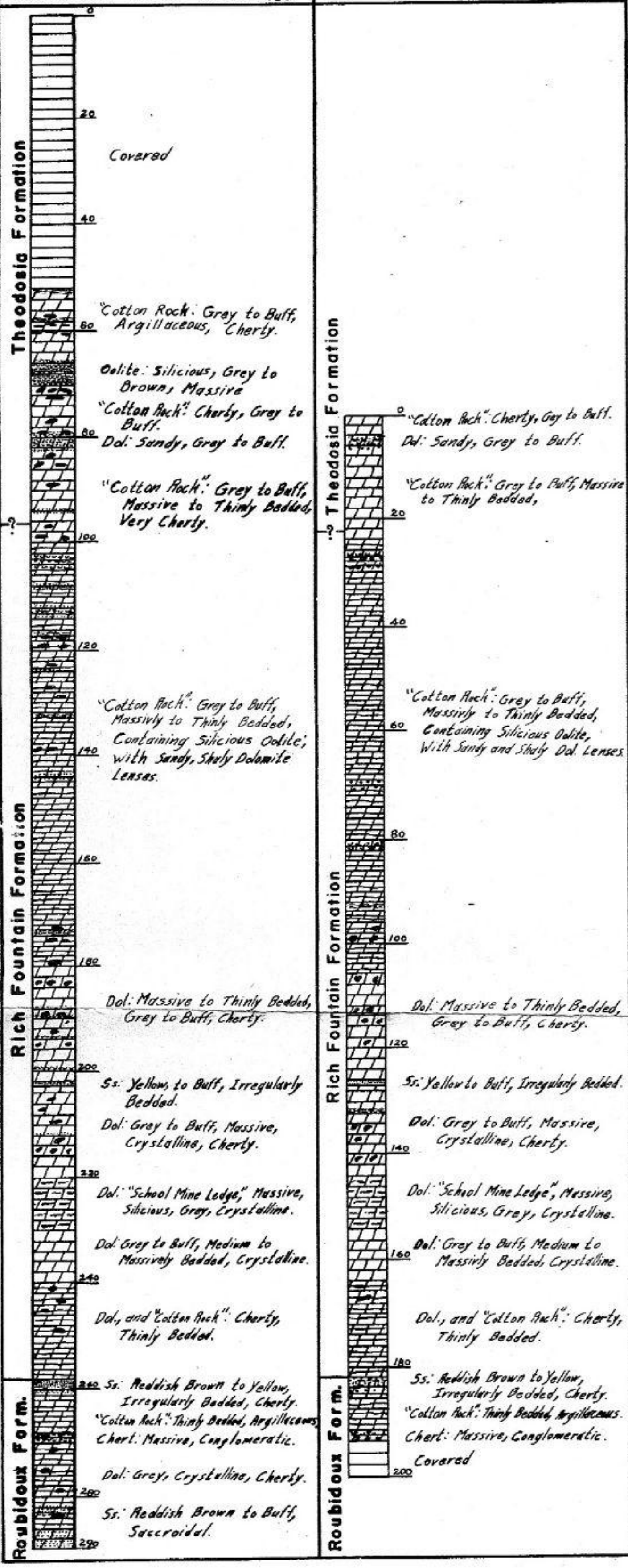
Dol: Grey, Crystalline to Fine Grained, Containing numerous Chert Nodules and Lentils; some Brecciated or Conglomeritic.
Some Scattered Sand Lentils

Shale: Bluish Green, Thin
Quarry Floor

PLATE XVII

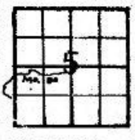
Section No. 6 State Mo. County Phelps
Quadrangle Rolla
Units Present
1. Theodosia
2. Rich Fountain
3. Roubidoux
4.
T. 37 N. R. 8 W.
Measured by: M.S.M. Water Well Date Drilled 1936

Section No. 5 State Mo. County Phelps
Quadrangle Rolla
Units Present
1. Theodosia
2. Rich Fountain
3. Roubidoux
4.
T. 37 N. R. 8 W.
Measured by J.S.C. Date 10/38


Theodosia Formation
Rich Fountain Formation
Roubidoux Form.
?
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
290
Covered
"Cotton Rock: Grey to Buff, Argillaceous, Cherty.
Oolite: Silicious, Grey to Brown, Massive
"Cotton Rock": Cherty, Grey to Buff.
Dol: Sandy, Grey to Buff.
"Cotton Rock": Grey to Buff, Massive to Thinly Bedded, Very Cherty.
"Cotton Rock": Grey to Buff, Massivly to Thinly Bedded, Containing Silicious Oolite; with Sandy, Shaly Dolomite Lenses.
Dol: Massive to Thinly Bedded, Grey to Buff, Cherty.
Ss: Yellow, to Buff, Irregularly Bedded.
Dol: Grey to Buff, Massive, Crystalline, Cherty.
Dol: "School Mine Ledge," Massive, Silicious, Grey, Crystalline.
Dol: Grey to Buff, Medium to Massively Bedded, Crystalline.
Dol., and "Cotton Rock": Cherty, Thinly Bedded.
Ss: Reddish Brown to Yellow, Irregularly Bedded, Cherty.
"Cotton Rock": Thinly Bedded, Argillaceous
Chert: Massive, Conglomeratic.
Dol: Grey, Crystalline, Cherty.
Ss: Reddish Brown to Buff, Saccroidal.
Theodosia Formation
Rich Fountain Formation
Roubidoux Form.
?
0
20
40
60
80
100
120
140
160
180
200
"Cotton Rock": Cherty, Grey to Buff.
Dol: Sandy, Grey to Buff.
"Cotton Rock": Grey to Buff, Massive to Thinly Bedded,
"Cotton Rock": Grey to Buff, Massivly to Thinly Bedded, Containing Silicious Oolite, With Sandy and Shaly Dol. Lenses.
Dol: Massive to Thinly Bedded, Grey to Buff, Cherty.
Ss: Yellow to Buff, Irregularly Bedded.
Dol: Grey to Buff, Massive, Crystalline, Cherty.
Dol: "School Mine Ledge", Massive, Silicious, Grey, Crystalline.
Dol: Grey to Buff, Medium to Massivly Bedded, Crystalline.
Dol., and "Cotton Rock": Cherty, Thinly Bedded.
Ss: Reddish Brown to Yellow, Irregularly Bedded, Cherty.
"Cotton Rock": Thinly Bedded, Argillaceous.
Chert: Massive, Conglomeratic.
Covered

CULLISON **PLATE XVIII**

Section No. 7 State Mo. County Ozark

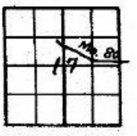


Quadrangle Gainesville

Units Present
1. Theodosia
2. Rich Fountain
3. Roubidoux
4.

T. 22 N R. 13 W.
Measured by J.S.C. Date 1938

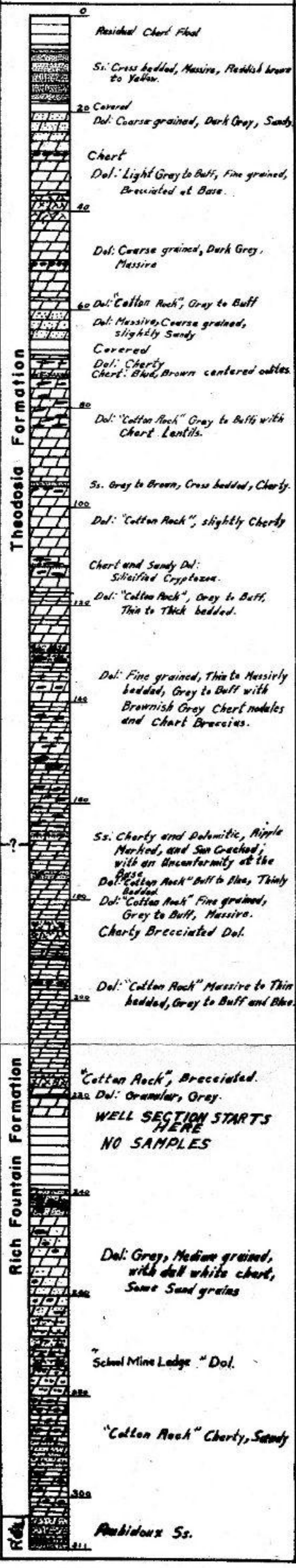
Section No. 8 State Mo. County Ozark

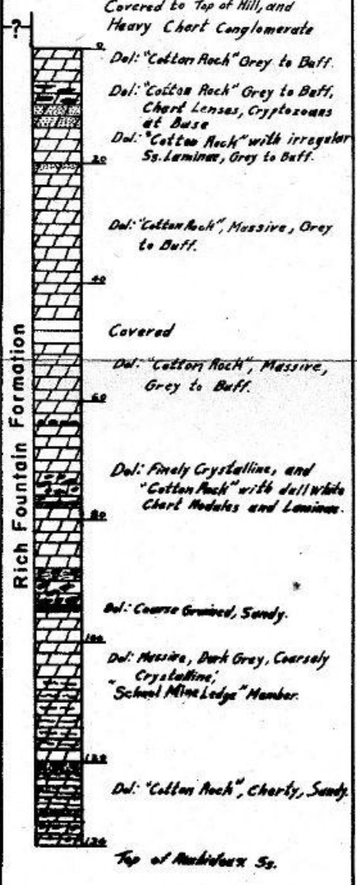


Quadrangle Gainesville

Units Present
1. Rich Fountain
2. Roubidoux
3.
4.

T 22 N R 12 W
Measured by J. S. C. Date 1938


Theodosia Formation
Rich Fountain Formation
Rdx
?
0
Residual Chert Float
Ss: Cross bedded, Massive, Reddish brown to Yellow.
20 Covered
Dol: Coarse grained, Dark Grey, Sandy
Chert
Dol: Light Gray to Buff, Fine grained, Brecciated at Base.
40
Dol: Coarse grained, Dark Grey, Massive
60 Dol: "Cotton Rock", Gray to Buff
Dol: Massive, Coarse grained, slightly Sandy
Covered
Dol: Cherty
Chert: Blue, Brown centered oolites.
80
Dol: "Cotton Rock" Grey to Buff with Chert Lentils.
Ss. Grey to Brown, Cross bedded, Cherty.
100
Dol: "Cotton Rock", slightly Cherty
Chert and Sandy Dol: Silicified Cryptozoa.
120 Dol: "Cotton Rock", Grey to Buff, Thin to Thick bedded.
Dol: Fine grained, Thin to Massively bedded, Grey to Buff with Brownish Grey Chert nodules and Chert Breccias.
140
160
Ss: Cherty and Dolomitic, Ripple Marked, and Sun Cracked; with an Unconformity at the Base
Dol: "Cotton Rock" Buff to Blue, Thinly Bedded
180 Dol: "Cotton Rock" Fine grained, Grey to Buff, Massive.
Cherty Brecciated Dol.
Dol: "Cotton Rock" Massive to Thin bedded, Grey to Buff and Blue.
200
"Cotton Rock", Brecciated.
220 Dol: Granular, Grey.
WELL SECTION STARTS HERE
NO SAMPLES
240
Dol: Grey, Medium grained, with dull white chert, Some Sand grains
260
"School Mine Ledge" Dol.
280
"Cotton Rock" Cherty, Sandy
300
Roubidoux Ss.
311


?
Rich Fountain Formation
Covered to Top of Hill, and Heavy Chert Conglomerate
0
Dol: "Cotton Rock" Grey to Buff.
Dol: "Cotton Rock" Grey to Buff, Chert Lenses, Cryptozoans at Base
Dol: "Cotton Rock" with irregular Ss. Laminae, Grey to Buff.
20
Dol: "Cotton Rock", Massive, Grey to Buff.
40
Covered
Dol: "Cotton Rock", Massive, Grey to Buff.
60
Dol: Finely Crystalline, and "Cotton Rock" with dull white Chert Nodules and Laminae.
80
Dol: Coarse Grained, Sandy.
100
Dol: Massive, Dark Grey, Coarsely Crystalline; "School Mine Ledge" Member.
120
Dol: "Cotton Rock", Cherty, Sandy.
126
Top of Roubidoux Ss.

CULLISON

PLATE XIX

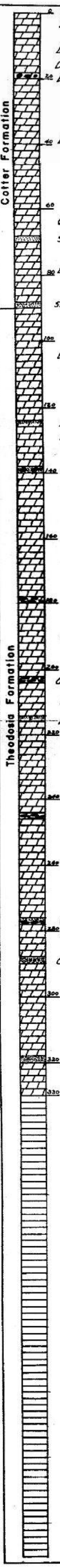
Section No. 9 State Mo. County Taney

Quadrangle Protem

Units Present
1. Cotter
2. Theodosia
3.
4.

T. 22 N R. 17 W

Measured by J. S. C. Date 1941



0 Top of Blackjack Knob

Dol: Grey to Buff, Crystalline

Dol: Conglomeritic

Dol: Grey to Buff, "Cotton Rock"

20 Dol: Buff to Grey, Granular, Cherty, Fossiliferous.

40 Dol: Grey, Massive to Medium Bedded, Fine to Medium Grained.

60

Cross Roads

Ss: Brown to Buff, Thin.

80 Dol: White to Buff, Fine Grained

Ss: Reddish Brown to Grey, very irregularly Bedded.

100

Dol: Grey to Buff, interbedded, Finely Crystalline, and "Cotton Rock"

120

Arenacious Zone

Dol: Grey to Buff; Interbedded finely Crystalline and "Cotton Rock"

140 Chert: Brown, Blocky, Arenacious.

160 Dol: Grey to Buff; Interbedded finely Crystalline and "Cotton Rock"

180 Chert: Bluish white to Buff, Dull, Slightly Oolitic.

Dol: Grey to Buff; Interbedded finely Crystalline, and "Cotton Rock"

200

Chert: Bluish white to Buff, Dull, Slightly Oolitic.

Dol: Grey to Buff; Interbedded finely Crystalline, and "Cotton Rock"

Arenacious Zone

220

240 Dol: Crystalline to fine Grained "Cotton Rock", Grey to Buff, some Thin Shale Beds, much Chert, very Fossiliferous.

260

Chert: Gray Brown, very Arenacious

280 Dol: Grey to Buff, Argillaceous "Cotton Rock"

Chert: Blue and Brown, Oolitic, Massive

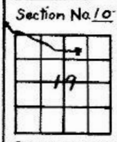
300 Dol: Grey to Buff, Argillaceous.

Chert: Black and White

320 Ss: Reddish Brown to Buff, Massive.

330 Bottom of Valley, On Road

Section No. 10 State Mo. County Ozark

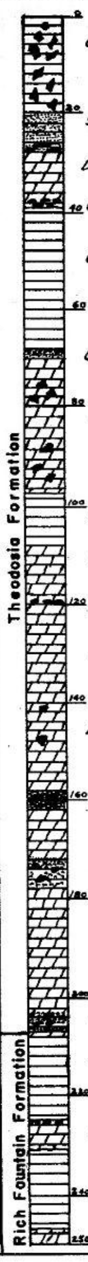


Quadrangle Thornfield

Units Present
1. Theodosia
2. Rich Fountain
3.
4.

T 22 N R 16 W

Measured by J. S. C. Date 1939



0

Chert: Residual, Cryptozoan Type, Grey and Blue Banded

20 Ss: Reddish Brown to Buff, Silicified and Cherty at Base.

Dol: Grey, Coarse grained, Crystalline, Massive.

40 Chert: Grey to Buff.

Covered with Ss. and Chert float

60

Chert: Reddish Brown, Grey, Oolitic, Arenacious, Blocky.

80 Dol: Grey to Buff, Medium to Thinly Bedded, Cherty.

100

Covered, probably the Same Dol: as above.

Dol: Grey, Buff, Medium to Thinly Bedded, Cherty.

120 Chert: Black and White, Nodular, Massive.

Dol: Grey to Buff, "Cotton Rock" with some Thin Ss. Lenses

140

Dol: Grey, Crystalline, Massive, Weathers Rough.

160 Dol: Grey, Massive, Crystalline, Weathers to porous, Crystalline, Siliceous Masses.

Dol: Grey, Massive, Crystalline, With interbedded "Cotton Rock" Layers. Contains Slotted Chert Conglomerate near Center.

180

200

Chert: Massive, Conglomeritic Sandy.

Covered: Much Residual Conglomeritic Chert Float.

220

Dol: Grey to Buff, "Cotton Rock"

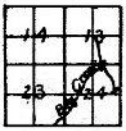
Covered (Valley Fill)

240

250 Dol: Grey, Fine Grained Bottom of River

PLATE XX

Section No. *11* State *Mo.* County *Taney*

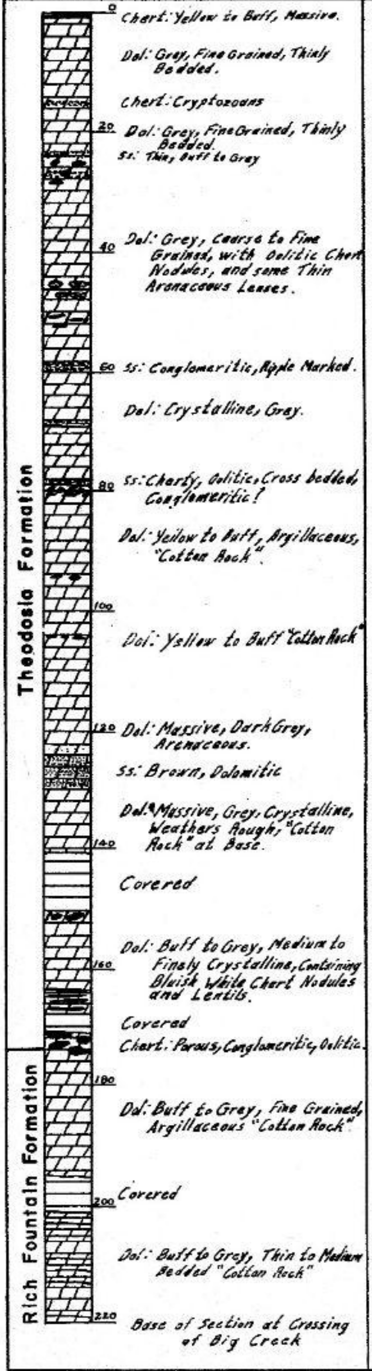


Quadrangle *Protem*

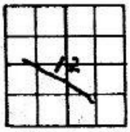
Units Present
1. Theodosia
2. Rich Fountain
3.
4.

T. *22, N.* R. *17, W.*

Measured by *J. S. C.* Date *1938*


Theodosia Formation
Rich Fountain Formation
0 Chert: Yellow to Buff, Massive.
Dol: Grey, Fine Grained, Thinly Bedded.
Chert: Cryptozoans
20 Dol: Grey, Fine Grained, Thinly Bedded.
Ss: Thin, Buff to Grey
40 Dol: Grey, Coarse to Fine Grained, with Oolitic Chert Nodules, and some Thin Arenaceous Lenses.
60 Ss: Conglomeritic, Ripple Marked.
Dol: Crystalline, Gray.
80 Ss: Cherty, Oolitic, Cross bedded, Conglomeritic!
Dol: Yellow to Buff, Argillaceous, "Cotton Rock".
100
Dol: Yellow to Buff "Cotton Rock"
120 Dol: Massive, Dark Grey, Arenaceous.
Ss: Brown, Dolomitic
Dol: Massive, Grey, Crystalline, Weathers Rough, "Cotton Rock" at Base.
140
Covered
Dol: Buff to Grey, Medium to Finely Crystalline, Containing Bluish White Chert Nodules and Lentils.
160
Covered
Chert: Porous, Conglomeritic, Oolitic.
180
Dol: Buff to Grey, Fine Grained, Argillaceous "Cotton Rock".
200 Covered
Dol: Buff to Grey, Thin to Medium Bedded "Cotton Rock"
220
Base of Section at Crossing of Big Creek

Section No. *12* State *Mo.* County *Taney*

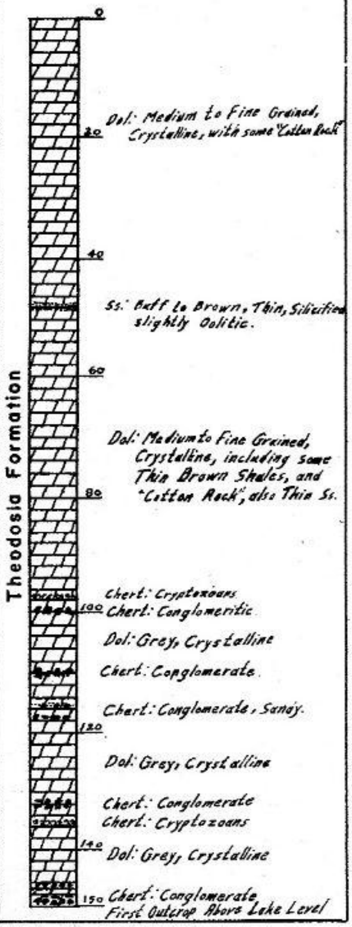


Quadrangle *Forsyth*

Units Present
1. Theodosia
2.
3.
4.

T. *23N.* R. *21, W.*

Measured by *J.S.C. + C.L.D.* Date *1931*


Theodosia Formation
0
20 Dol: Medium to Fine Grained, Crystalline, with some "Cotton Rock"
40
Ss: Buff to Brown, Thin, Silicified slightly Oolitic.
60
Dol: Medium to Fine Grained, Crystalline, including some Thin Brown Shales, and "Cotton Rock", also Thin Ss.
80
Chert: Cryptozoans
100 Chert: Conglomeritic
Dol: Grey, Crystalline
Chert: Conglomerate.
Chert: Conglomerate, Sandy.
120
Dol: Grey, Crystalline
Chert: Conglomerate
Chert: Cryptozoans
140 Dol: Grey, Crystalline
150 Chert: Conglomerate
First Outcrop Above Lake Level

CULLISON

PLATE XXI

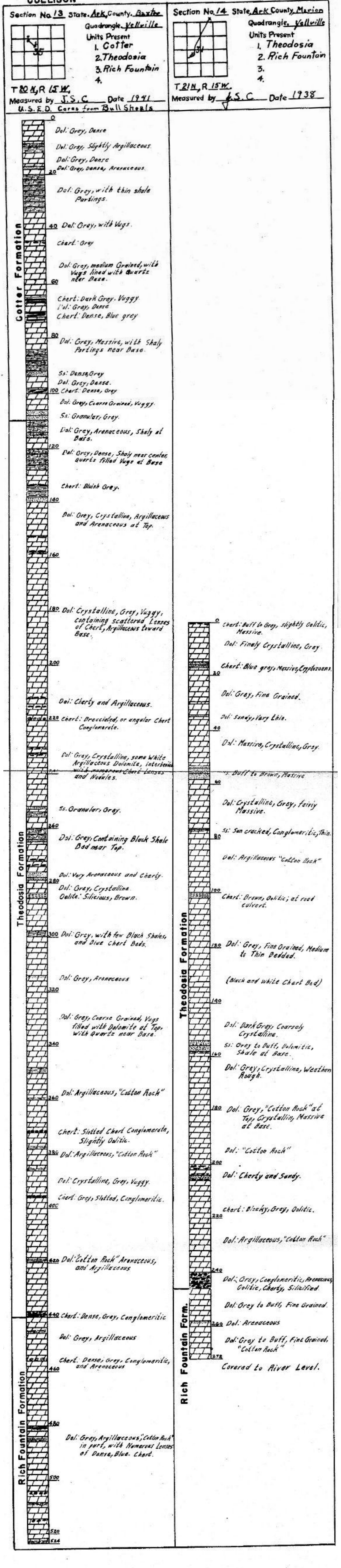
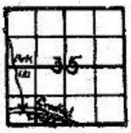
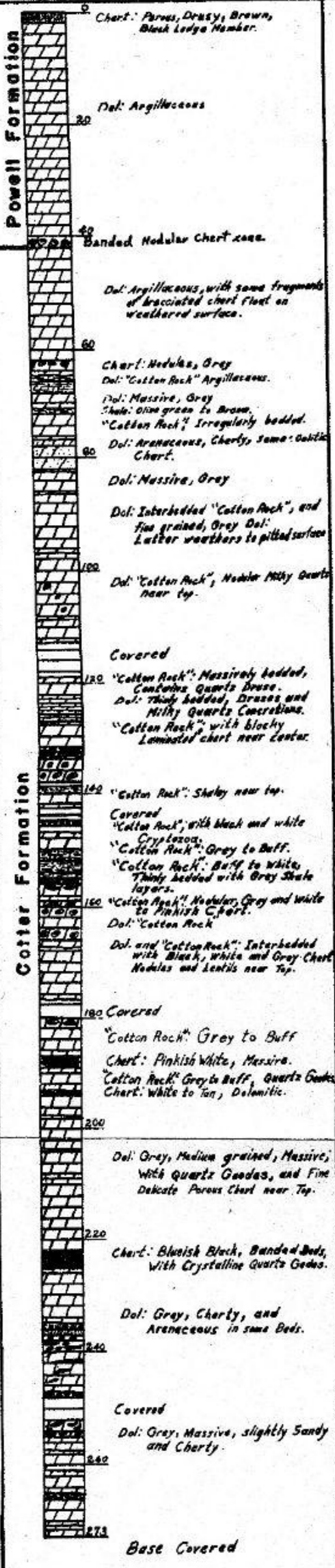

Section No. 13 State. Ark. County. Baxter
Quadrangle. Yellville
Units Present
1. Cotter
2. Theodosia
3. Rich Fountain
4.
35
T 20 N, R 15 W.
Measured by J. S. C. Date 1941
U.S.E.D. Cores from Bull Shoals
0
Dol: Grey, Dense
Dol: Grey, Slightly Argillaceous
Dol: Grey, Dense
Dol: Grey, Dense, Arenaceous
20
Dol: Grey, with thin shale Partings.
40
Dol: Grey, with Vugs.
Chert: Grey
Dol: Grey, medium Grained, with Vugs lined with Quartz near Base.
60
Chert: Dark Grey. Vuggy
Dol: Grey, Dense
Chert: Dense, Blue grey
80
Dol: Grey, Massive, with Shaly Partings near Base.
Ss: Dense, Grey
Dol: Grey, Dense.
100
Chert: Dense, Grey
Dol: Grey, Coarse Grained, Vuggy.
Ss: Granular, Grey.
Dol: Grey, Arenaceous, Shaly at Base.
120
Dol: Grey, Dense, Shaly near center, quartz filled Vugs at Base
Chert: Bluish Grey.
140
Dol: Grey, Crystalline, Argillaceous and Arenaceous at Top.
160
180
Dol: Crystalline, Grey, Vuggy, containing scattered Lenses of Chert, Argillaceous toward Base.
200
Dol: Cherty and Argillaceous.
220
Chert: Brecciated, or angular Chert Conglomerate.
Dol: Grey, Crystalline, some White Argillaceous Dolomite, interbedded with numerous Chert Lenses and Nodules.
240
Ss. Granular, Grey.
260
Dol: Grey, Containing Black Shale Bed near Top.
Dol: Very Arenaceous and Cherty.
280
Dol: Grey, Crystalline
Oolite: Silicious, Brown.
300
Dol: Grey, with few Black Shales, and Blue Chert Beds.
Dol: Grey, Arenaceous
320
Dol: Grey, Coarse Grained, Vugs filled with Dolomite at Top, with Quartz near Base.
340
Dol: Argillaceous, "Cotton Rock"
360
Chert: Slotted Chert Conglomerate, Slightly Oolitic.
380
Dol: Argillaceous, "Cotton Rock"
Dol: Crystalline, Grey, Vuggy.
Chert: Grey, Slotted, Conglomeritic.
400
420
Dol: "Cotton Rock" Arenaceous, and Argillaceous
440
Chert: Dense, Grey, Conglomeritic
Dol: Grey, Argillaceous
Chert: Dense, Grey, Conglomeritic, and Arenaceous
460
480
Dol: Grey, Argillaceous, "Cotton Rock" in part, with Numerous Lenses of Dense, Blue Chert.
500
520
524
Cotter Formation
Theodosia Formation
Rich Fountain Formation
Section No. 14 State, Ark County, Marion
Quadrangle, Yellville
Units Present
1. Theodosia
2. Rich Fountain
3.
4.
31
T 21 N, R 15 W.
Measured by J. S. C. Date 1938
0
Chert: Buff to Grey, slightly Oolitic, Massive.
Dol: Finely Crystalline, Grey
Chert: Blue grey, Massive, Cryptozoans.
20
Dol: Grey, Fine Grained.
Dol: Sandy, Very thin.
40
Dol: Massive, Crystalline, Grey.
Ss: Buff to Brown, Massive
60
Dol: Crystalline, Grey, fairly Massive.
Ss: Sun cracked, Conglomeritic, Thin.
80
Dol: Argillaceous "Cotton Rock"
100
Chert: Brown, Oolitic; at road culvert.
120
Dol: Grey, Fine Grained, Medium to Thin Bedded.
(Black and white Chert Bed)
140
Dol: Dark Grey, Coarsely Crystalline.
Ss: Grey to Buff, Dolomitic, Shale at Base.
160
Dol: Grey, Crystalline, Weathers Rough.
180
Dol: Grey, "Cotton Rock" at Top, Crystallin, Massive at Base.
Dol: "Cotton Rock"
200
Dol: Cherty and Sandy.
Chert: Blocky, Grey, Oolitic.
220
Dol: Argillaceous, "Cotton Rock"
240
Dol: Grey, Conglomeritic, Arenaceous, Oolitic, Cherty, Silicified.
Dol: Grey to Buff, Fine Grained.
260
Dol: Arenaceous
Dol: Grey to Buff, Fine Grained, "Cotton Rock"
272
Covered to River Level.
Theodosia Formation
Rich Fountain Form.

PLATE XXII

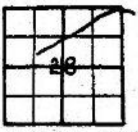
Section No. 15 State Ark County Marion



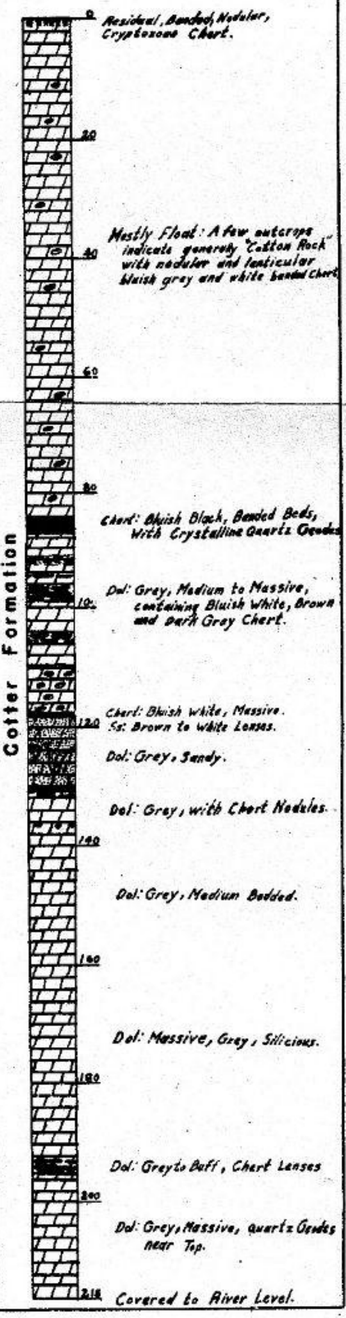
Quadrangle Yellville
Units Present
1. Powell
2. Cotter
3.
4.
T. 19N R. 15W
Measured by J.S.C Date 7/38


Powell Formation
Cotter Formation
0
Chert: Porous, Drusy, Brown, Black Ledge Member.
Dol: Argillaceous
20
40
Banded Nodular Chert zone.
Dol: Argillaceous, with some fragments of brecciated chert float on weathered surface.
60
Chert: Nodules, Grey
Dol: "Cotton Rock" Argillaceous.
Dol: Massive, Grey
Shale: Olive green to Brown.
"Cotton Rock": Irregularly bedded.
Dol: Arenaceous, Cherty, some Oolitic Chert.
80
Dol: Massive, Grey
Dol: Interbedded "Cotton Rock", and fine grained, Grey Dol: Latter weathers to pitted surface
100
Dol: "Cotton Rock", Nodular Milky Quartz near top.
Covered
120
"Cotton Rock": Massively bedded, Contains Quartz Druse.
Dol: Thinly bedded, Druses and Milky Quartz Concretions.
"Cotton Rock": with blocky Laminated chert near center.
140
"Cotton Rock": Shaley near top.
Covered
"Cotton Rock", with black and white Cryptozoa.
"Cotton Rock": Grey to Buff.
"Cotton Rock": Buff to white, Thinly bedded with Grey Shale layers.
160
"Cotton Rock": Nodular, Grey and white to Pinkish Chert.
Dol: "Cotton Rock
Dol. and "Cotton Rock": Interbedded with Black, white and Grey Chert Nodules and Lentils near Top.
180
Covered
"Cotton Rock": Grey to Buff
Chert: Pinkish White, Massive.
"Cotton Rock": Grey to Buff, Quartz Geodes
Chert: White to Tan, Dolomitic.
200
Dol: Grey, Medium grained, Massive, With Quartz Geodes, and Fine Delicate Porous Chert near Top.
220
Chert: Bluish Black, Banded Beds, With Crystalline Quartz Geodes.
Dol: Grey, Cherty, and Arenaceous in some Beds.
240
Covered
Dol: Grey, Massive, slightly Sandy and Cherty.
260
273
Base Covered

Section No. 16 State Ark County Marion

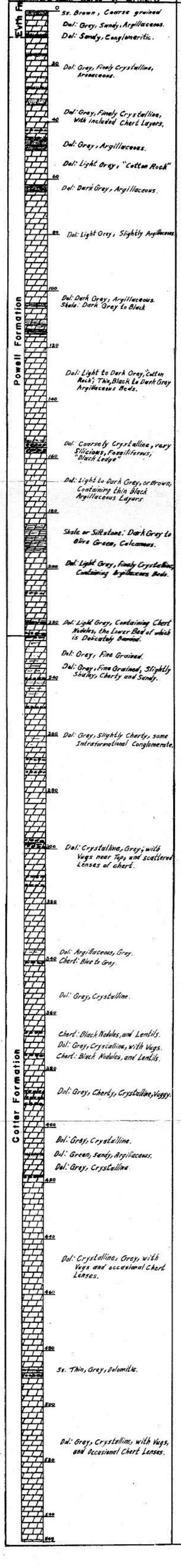


Quadrangle Yellville
Units Present
1. Cotter
2.
3.
4.
T 19N R 15W
Measured by J.S.C Date 6/'39


Cotter Formation
0
Residual, Banded, Nodular, Cryptozoone Chert.
20
40
Mostly Float: A few outcrops indicate generally "Cotton Rock" with nodular and lenticular bluish grey and white banded Chert
60
80
Chert: Bluish Black, Banded Beds, With Crystalline Quartz Geodes
100
Dol: Grey, Medium to Massive, containing Bluish White, Brown and Dark Grey Chert.
120
Chert: Bluish white, Massive.
Ss: Brown to White Lenses.
Dol: Grey, Sandy.
Dol: Grey, with Chert Nodules.
140
Dol: Grey, Medium Bedded.
160
Dol: Massive, Grey, Silicious.
180
Dol: Grey to Buff, Chert Lenses
200
Dol: Grey, Massive, quartz Geodes near Top.
218
Covered to River Level.

CULLISON **PLATE XXIII**

Section No. 17 State Ark, County Baxter
Quadrangle Mtn Home
Units Present
1. Everton
2. Powell
3. Cotter
4.
T 18 N, R 13 W,
Measured by J. S. C Date 1941
Norfork Dam Corps of U.S.E.D


Evtn Fm
Powell Formation
Cotter Formation
0
Ss. Brown, Coarse grained
Dol: Grey, Sandy, Argillaceous.
Dol: Sandy, Conglomeritic.
20
Dol: Grey, Finely Crystalline, Areaceous.
40
Dol: Grey, Finely Crystalline, with included Chert Layers,
Dol: Grey, Argillaceous.
Dol: Light Grey, "Cotton Rock"
60
Dol: Dark Grey, Argillaceous.
80
Dol: Light Grey, Slightly Argillaceous.
100
Dol: Dark Grey, Argillaceous.
Shale: Dark Grey to Black
120
Dol: Light to Dark Grey, "Cotton Rock"; Thin, Black to Dark Grey Argillaceous Beds.
140
Dol: Coarsely Crystalline, very Silicious, Fossiliferous, "Black Ledge"
160
Dol: Light to Dark Grey, or Brown, Containing thin Black Argillaceous Layers.
180
Shale or Siltstone: Dark Grey to Olive Green, Calcareous.
200
Dol: Light Grey, finely Crystalline, Containing Argillaceous Beds.
220
Dol: Light Grey, Containing Chert Nodules, the Lower Bed of which is Delicately Banded.
Dol: Grey, Fine Grained.
Dol: Grey, Fine Grained, Slightly Shaley, Cherty and Sandy.
240
260
Dol: Grey, Slightly Cherty, some Intraformational Conglomerate.
280
300
Dol: Crystalline, Grey; with Vugs near Top, and scattered Lenses of chert.
320
Dol: Argillaceous, Grey.
340
Chert: Blue to Grey.
Dol: Grey, Crystalline.
360
Chert: Black Nodules, and Lentils.
Dol: Grey, Crystalline, with Vugs.
Chert: Black Nodules, and Lentils.
380
Dol: Grey, Cherty, Crystalline, Vuggy.
400
Dol: Grey, Crystalline.
Dol: Green, sandy, Argillaceous.
Dol: Grey, Crystalline
420
440
Dol: Crystalline, Grey, with Vugs and occasional Chert Lenses.
460
480
Ss. Thin, Grey, Dolomitic.
500
Dol: Grey, Crystalline, with Vugs, and Occasional Chert Lenses.
520
540
549

Section No. 18 State Ark County Marion
Quadrangle Yellville
Units Present
1. Powell
2.
3.
4.
T 19 N, R 16 W
Measured by J.S.C + J.B. Date 1939

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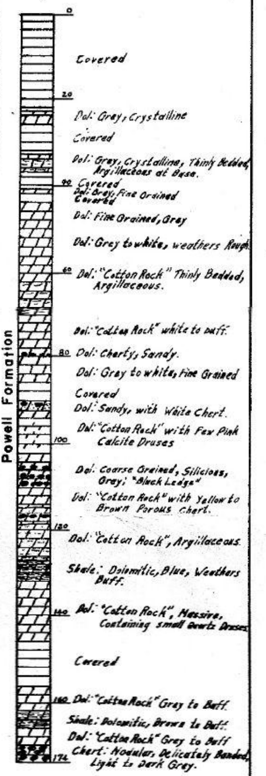
TALLAHASSEE, FLORIDA


Powell Formation
0
Covered
20
Dol: Grey, Crystalline
Covered
Dol: Grey, Crystalline, Thinly Bedded, Argillaceous at Base.
40
Covered
Dol: Grey, Fine Grained
Covered
Dol: Fine Grained, Grey
Dol: Grey to white, weathers Rough
60
Dol: "Cotton Rock" Thinly Bedded, Argillaceous.
Dol: "Cotton Rock" white to buff.
80
Dol: Cherty, Sandy.
Dol: Gray to white, Fine Grained
Covered
Dol: Sandy, with White Chert.
Dol: "Cotton Rock" with Few Pink Calcite Druses
100
Dol: Coarse Grained, Silicious, Grey; "Black Ledge"
Dol: "Cotton Rock" with Yellow to Brown Porous Chert.
120
Dol: "Cotton Rock", Argillaceous.
Shale: Dolomitic, Blue, Weathers Buff.
140
Dol: "Cotton Rock", Massive, Containing small Quartz Druses
Covered
160
Dol: "Cotton Rock" Grey to Buff.
Shale: Dolomitic, Brown to Buff.
Dol: "Cotton Rock" Grey to Buff
Chert: Nodular, Delicately Banded, Light to Dark Grey.
174

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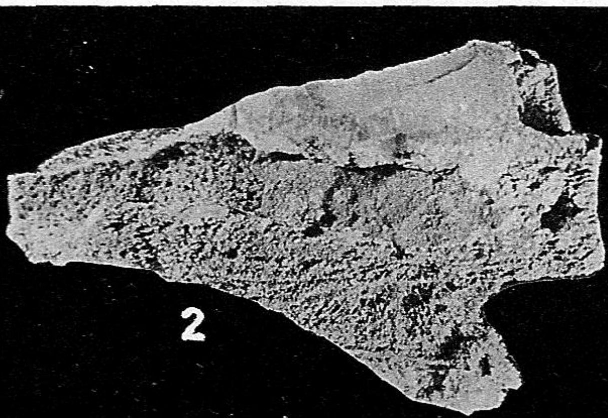
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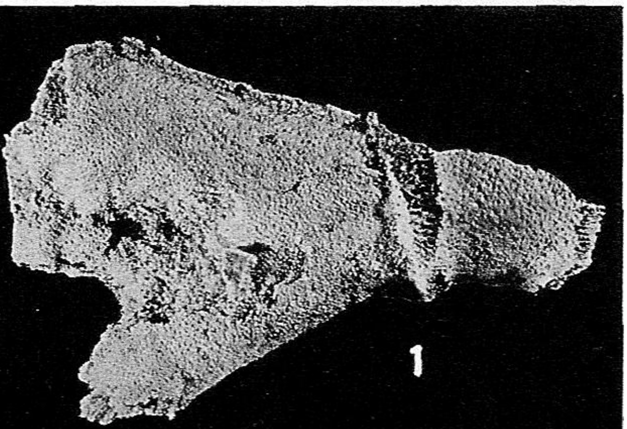
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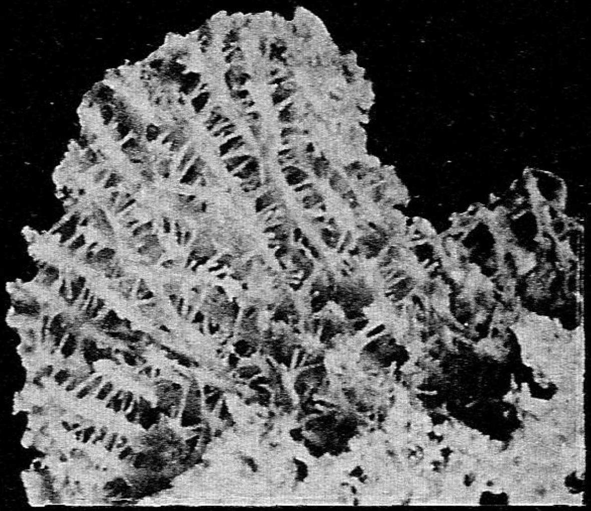
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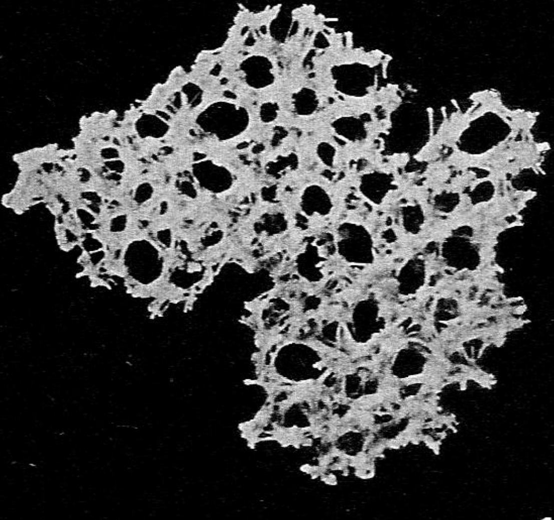
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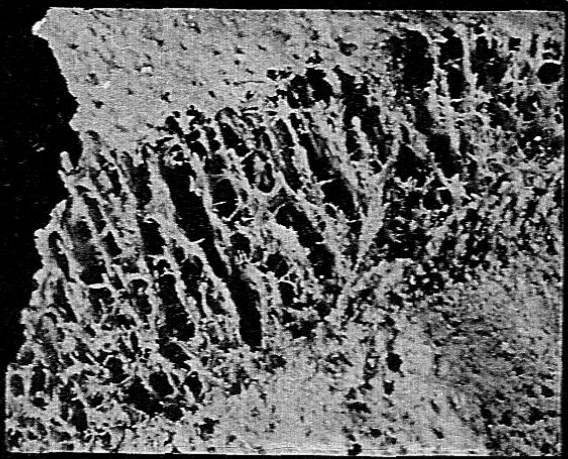
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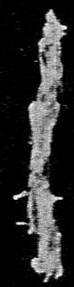
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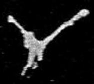
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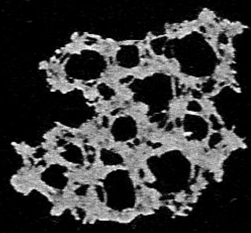
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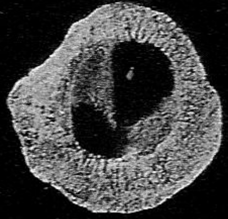
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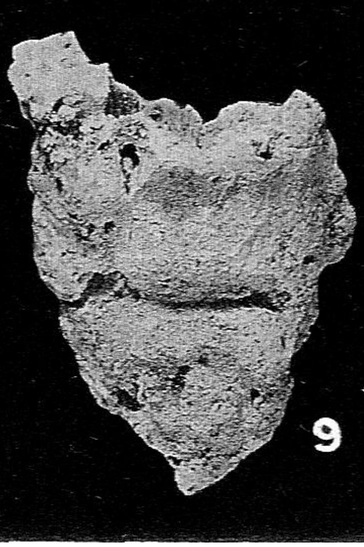
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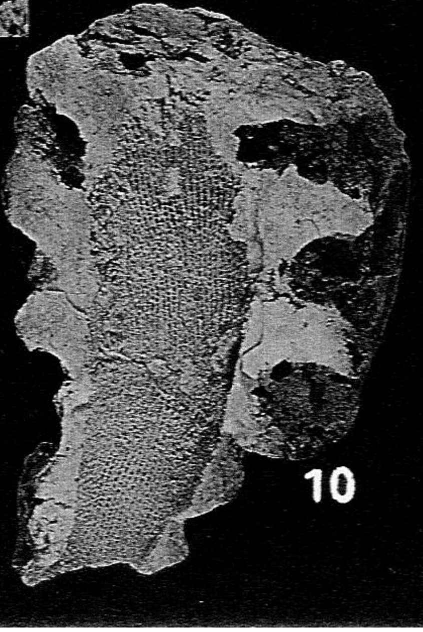
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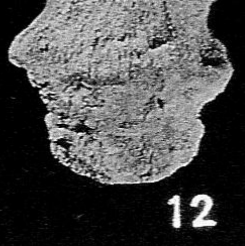
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PLATE XXIV.—**OZARKOCOELIA** and **ARCHAEOSCYPHIA**

Page

Ozarkocoelia irregularis n. sp. 47

Figures 1, 2. Holotype Y. P. M. 17136, two lateral views: (1) showing surface character, (2) structure of wall. M. S. M. locality 72.53, X 1.

Figure 3. Detailed view of spicular structure at lower left-hand tip of figure 1, X 10.

Figure 4. Detailed view of outer wall spicular structure of fragment from Holotype, X 10.

Figure 5. Detailed view of abraded transverse ridge from right center of figure 1 of holotype showing middle wall structure, X 5.

Figures 6-8. Views of spicular column, junction of three spicules, and small section of outer wall, fragments obtained during etching of holotype, X 10.

Archaeoscyphia annulata n. sp. 48

Figure 9. Paratype M. S. M. 7217, lateral view, M. S. M. locality 72.42, X .5.

Figure 10. Holotype Y. P. M. 17135, view of natural longitudinal section through cloaca, M. S. M. locality 72.42, X .5.

Figures 11, 12. Paratype M. S. M. 7218, top and lateral views of abraded specimen, M. S. M. locality 106.23, X .5.

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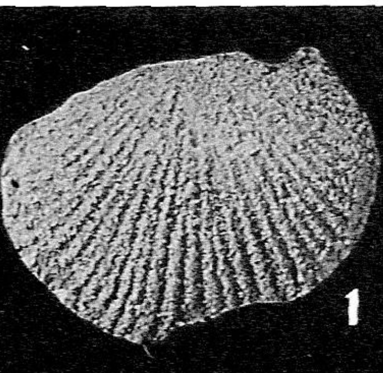
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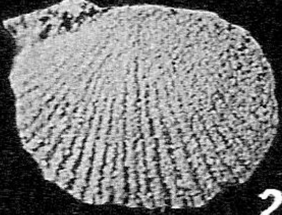
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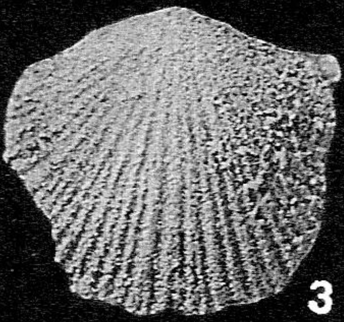
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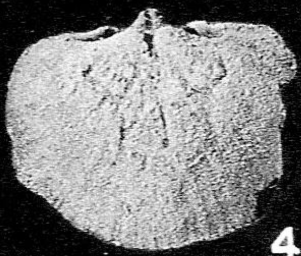
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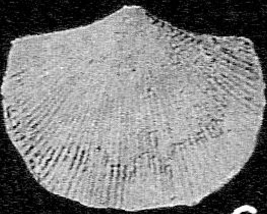
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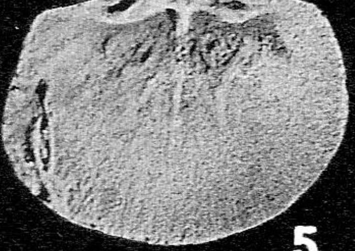
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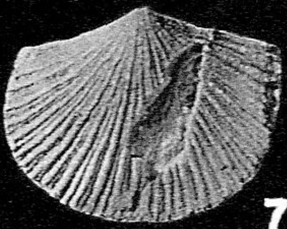
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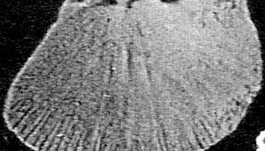
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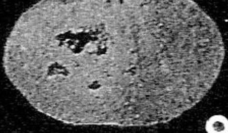
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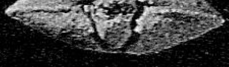
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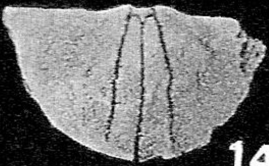
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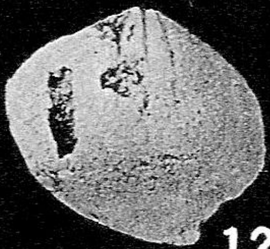
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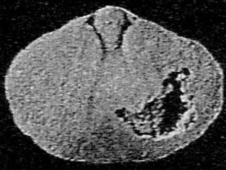
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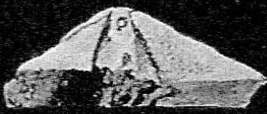
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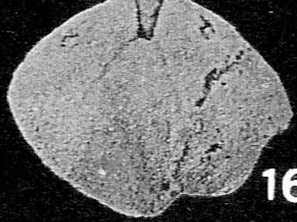
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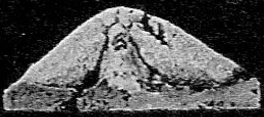
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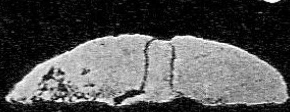
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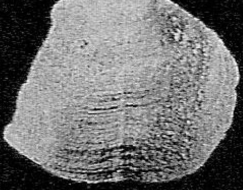
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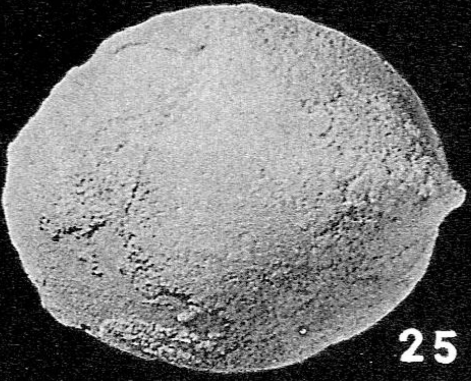
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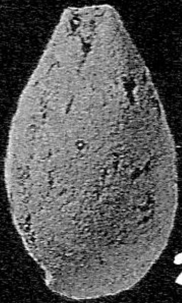
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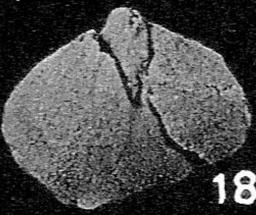
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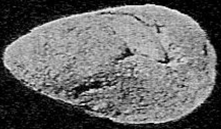
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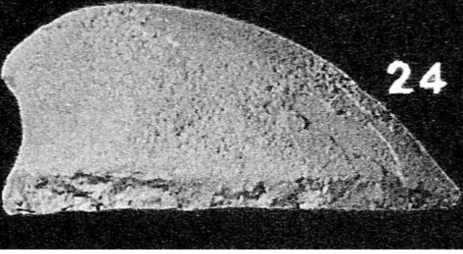
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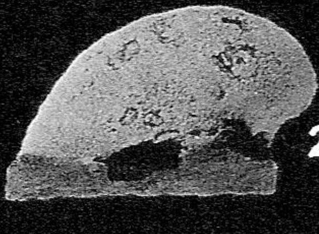
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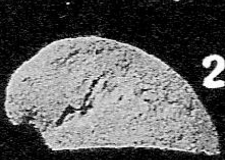
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PLATE XXV.—DIPARELASMA, TRITOECHIA, POLYTOECHIA, SYNTROPHOPSIS, PROPLINA

Page

Diparelasma silicum Ulrich and Cooper ---------- 48

Figure 1. Figured specimen M. S. M. 7226, ventral exterior, M. S. M. locality A4.9, X 6.

Figure 2. Figured specimen Y. P. M. 17130, dorsal exterior of small specimen, M. S. M. locality A4.8, X 6.

Figure 3. Figured specimen M. S. M. 7227, ventral exterior, M. S. M. locality A4.8, X 6.

Tritoechia cf *delicatula* Ulrich and Cooper ---------- 49

Figures 4, 5. Figured specimen M. S. M. 7228, (4) rubber cast of interior of figure 5, (5) dorsal interior showing muscle scars, M. S. M. locality 105.16, X 2.

Figure 6. Figured specimen M. S. M. 7229, ventral exterior, M. S. M. locality 105.16, X 2.

Tritoechia typica Ulrich and Cooper ---------- 49

Figure 7. Figured specimen M. S. M. 7230, ventral exterior, M. S. M. locality 105.18, X 2.

Figure 8. Figured specimen M. S. M. 7231 dorsal interior, M. S. M. locality 105 16, X 2.

Polytoechia inaequistriata Ulrich and Cooper ---------- 49

Figures 12, 13. Figured specimen M. S. M. 7232, ventral exterior and posterior ventral exterior of internal mould, M. S. M. locality A5.6, X 2.

Figures 14, 15. Figured specimen Y. P. M. 17131, ventral exterior and posterior ventral exterior of internal mould, M. S. M. locality A5.6, X 2.

Syntrophopsis arkansasensis Ulrich and Cooper ---------- 50

Figures 9-11. Figured specimen M. S. M. 7259, dorsal exterior, posterior exterior, and ventral exterior of internal mould, M. S. M. locality A4.10, X 2.

Syntrophopsis grandis n. sp. ---------- 50

Figures 16, 17. Holotype Y. P. M. 17132, ventral exterior and posterior ventral exterior of an internal mould, M. S. M. locality A5.6, X 2.

Figure 18. Paratype M. S. M. 7233, ventral exterior of internal mould, M. S. M. locality A5.6, X 2.

Figure 19. Paratype Y. P. M. 17133, dorsal exterior of a rubber cast of an external mould, M. S. M. locality A5.6, X 2.

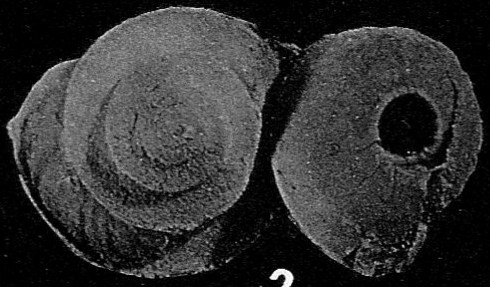
Proplina elongata n. sp. ---------- 50

Figures 20, 21. Holotype M. S. M. 7263, profile and dorsal view of internal mould, M. S. M. locality 72.51, X 1.

Figures 22, 23. Paratype Y. P. M. 17134, profile and dorsal view of internal mould, M. S. M. locality 57.1, X 1.

Proplina grandis n. sp. ---------- 51

Figures 24, 25. Holotype M. S. M. 7234, profile and dorsal view of internal mould, M. S. M. locality 103.2, X 1.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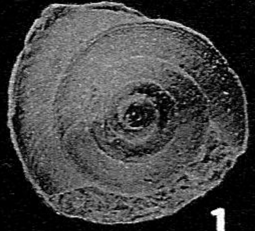
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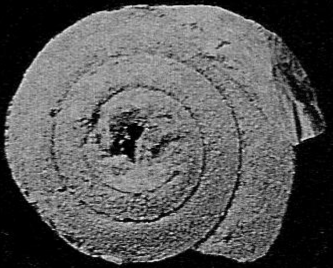
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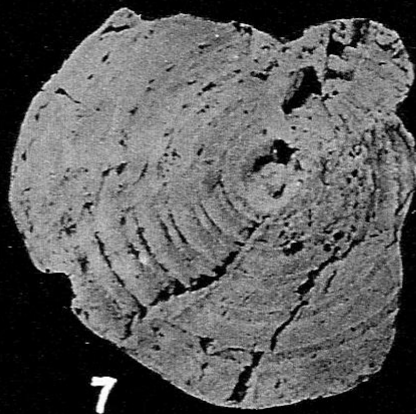
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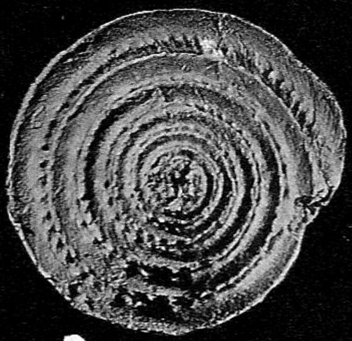
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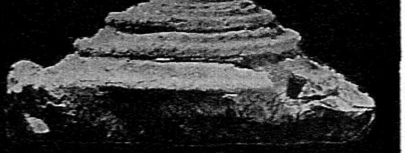
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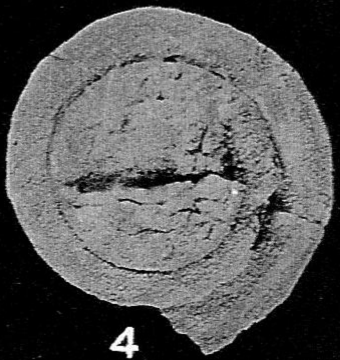
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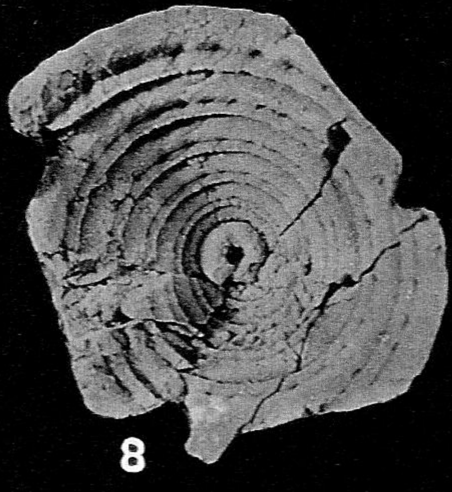
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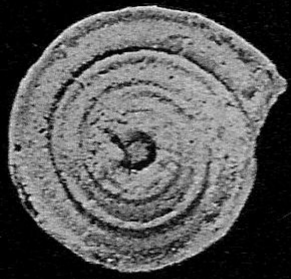
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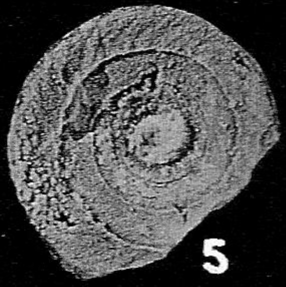
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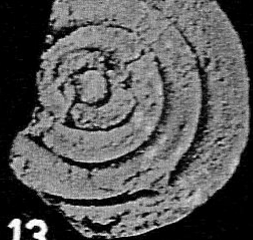
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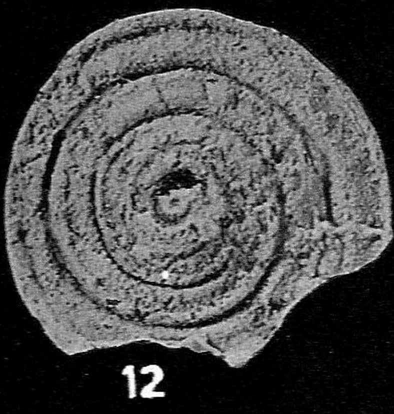
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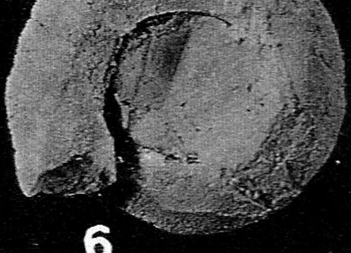
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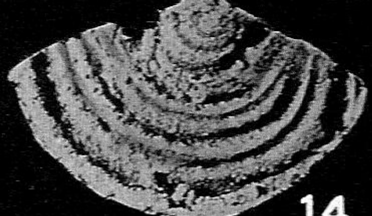
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PLATE XXVI.—**RAPHISTOMINA, OPHILETA, OROSPIRA**

Page

Raphistomina inflata n. sp. -- 51

Figure 1. Holotype M. S. M. 7201, dorsal view, M. S. M. locality 105.4, X 1.

Figure 2. Paratype Y. P. M. 17139, dorsal and ventral view, M. S. M. locality 105.4, X 1.

Ophileta sculpta n. sp. -- 52

Figure 3. Paratype M. S. M. 7205, dorsal view, M. S. M. locality 75.28, X 1.

Figures 4, 6. Holotype Y. P. M. 17140, dorsal and ventral views, M. S. M. locality 75.28, X 1.

Figure 5. Paratype M. S. M. 7206, view of external mould of spire showing ornamentation, M. S. M. locality 75.28, X 1.

Orospira conica n. sp. -- 54

Figure 7. Rubber cast of holotype, X 2.

Figure 8. Holotype M. S. M. 7207, external mould of spire, M. S. M. locality 106.4, X 2.

Orospira gainesvillensis n. sp. -- 53

Figures 9, 10. Holotype M. S. M. 7208, dorsal and profile view, M. S. M. locality 106.6, X 1.

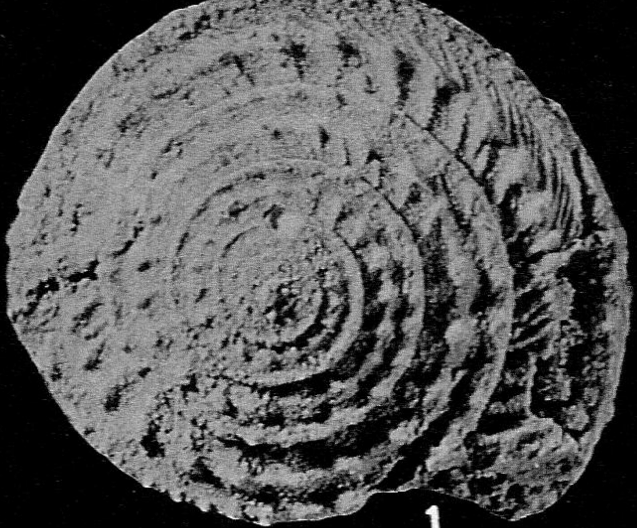
Orospira depressa n. sp. -- 53

Figure 11. Specimen Y. P. M. 17141, dorsal view of rubber cast of the Holotype (an external mould), M. S. M. locality 75.23, X 2.

Figure 12. Specimen Y. P. M. 17141, dorsal view of rubber cast of the paratype (an external mould), M. S. M. locality 75.23, X 2.

Orospira elevata n. sp. -- 54

Figure 13. Paratype, Y. P. M. 17143, a dorsal view of the internal mould, M. S. M. locality 72.42, X 2.



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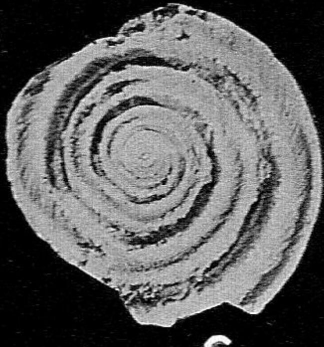

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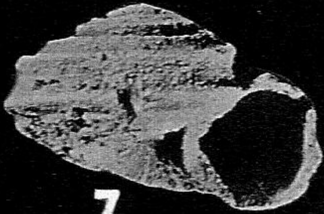

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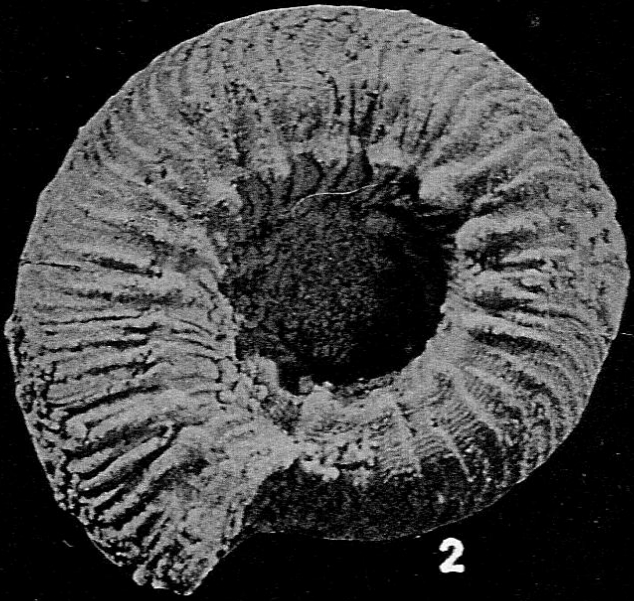

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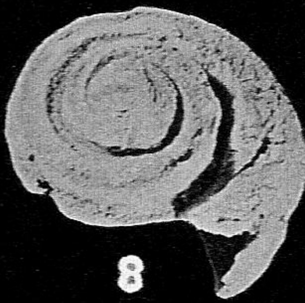

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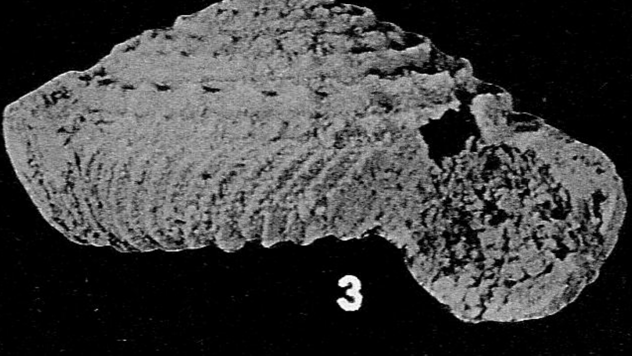

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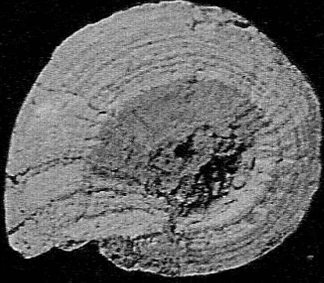

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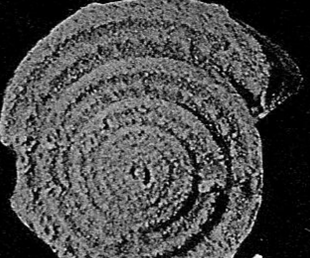

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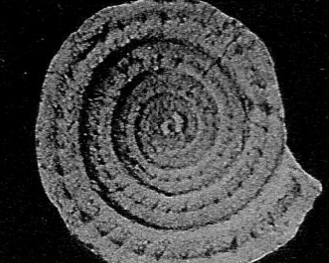

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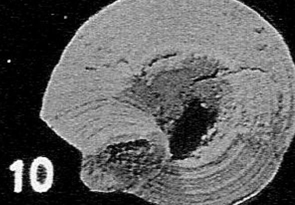

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PLATE XXVII.—**OROSPIRA, POLHEMIA**

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Orospira elegantula n. sp. -- 53

Figures 1-3. Holotype Y. P. M. 17142 dorsal, ventral and profile view (a silica replacement), M. S. M. locality 106.11, X 4.

Figures 4, 5. Paratype M. S. M. 7211, dorsal view of cast of external mould and ventral view of dorsal external mould, M. S. M. locality A5.3, X 2.

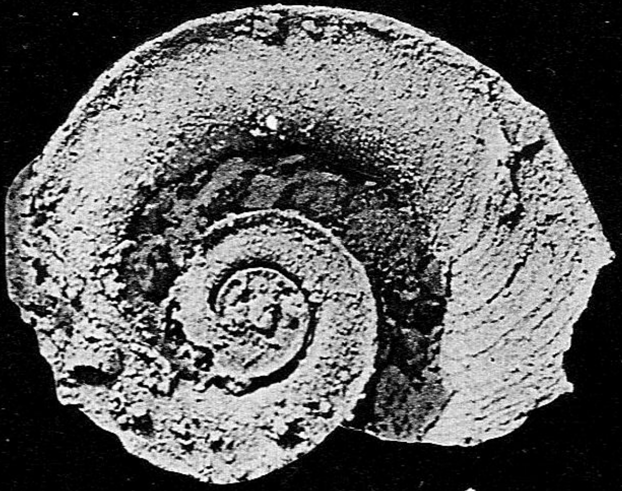
Polhemia taneyensis n. sp. -- 55

Figure 6. Holotype Y. P. M. 17144 dorsal view, (A silica replacement), locality 105.4, X 2.

Figures 7, 8. Paratype M. S. M. 7203, profile view showing shape of aperture and keels and inclined dorsal view showing apertural notch, M. S. M. locality 105.4, X 2.

Figure 9. Paratype M. S. M. 7204, umbilical view showing two ventral keels, M. S. M. locality 105.4, X 2.

Figure 10. Paratype Y. P. M. 17145, umbilical view showing narrow umbilicus, M. S. M. locality 105.4, X 2.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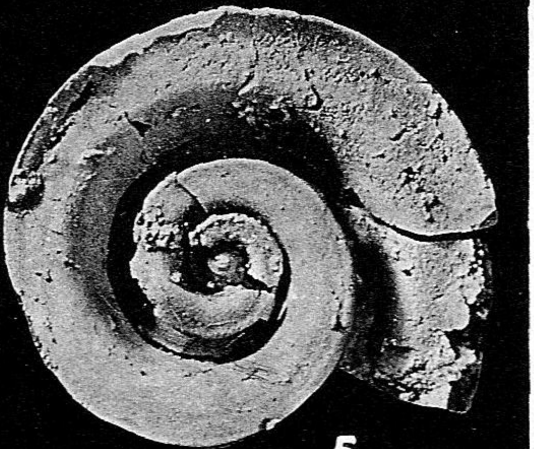
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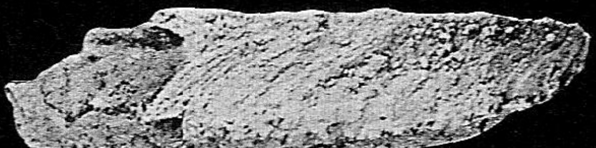
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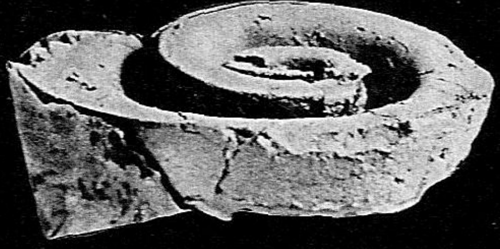
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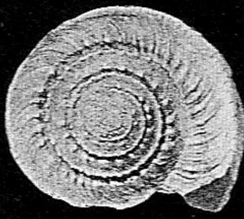
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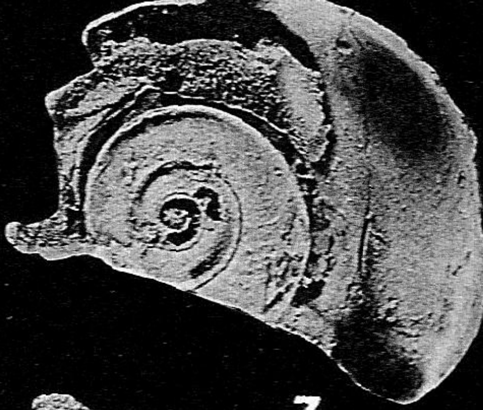
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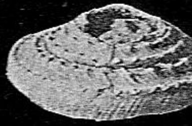
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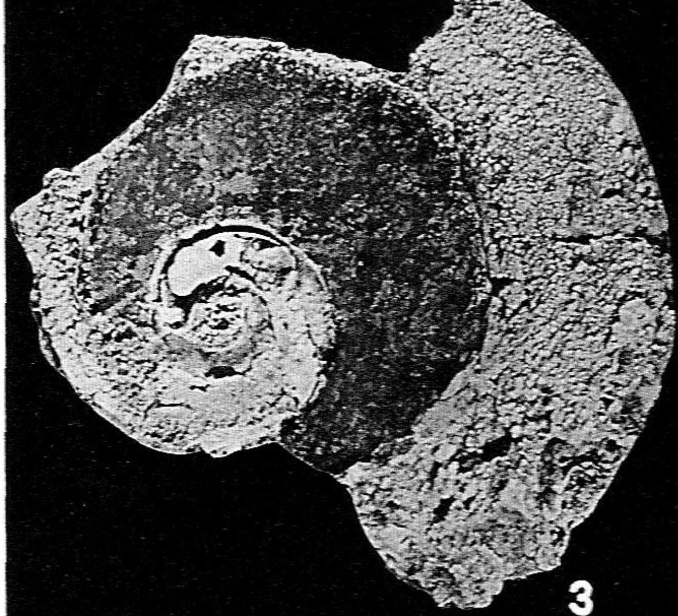
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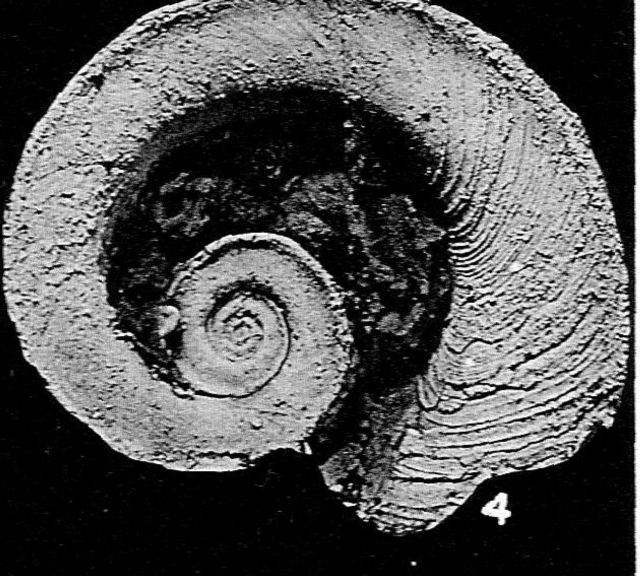
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PLATE XXVIII.—LESEURILLA, OROSPIRA

Page

Leseurilla isabellaensis n. sp. -- 56

Figures 1, 2. Paratype M. S. M. 7219, dorsal and profile views of rubber cast of an external mould. M. S. M. locality 106.11, X 1.

Figure 3. Paratype Y. P. M. 17126, dorsal view of a partial internal and external mould, M. S. M. locality 106.11, X 1.

Figure 4. Holotype U. S. N. M. ——, dorsal view of a rubber cast of the external mould, Ulrich's locality 101p, M. S. M. locality 106.11, X 1.

Leseurilla planodorsalis n. sp. -- 55

Figures 5, 6. Holotype U. S. N. M. ----, dorsal and slightly inclined lateral views of internal mould. Ulrich's locality 101o, X 1.

Leseurilla grandis n. sp. -- 56

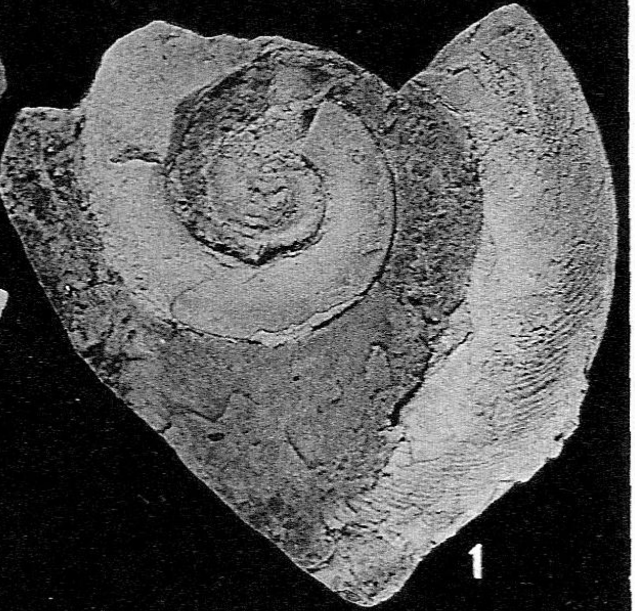
Figure 7. Holotype U. S. N. M. ----, dorsal view of partially internal and partially external mould, Ulrich's locality 281b, X 1.

Orospira bigranosa -- 52

Figure 8. Holotype U. S. N. M. ----, dorsal view.

Figure 9. Paratype U. S. N. M. ----, lateral view.

(Figures copied from Knight 1941)



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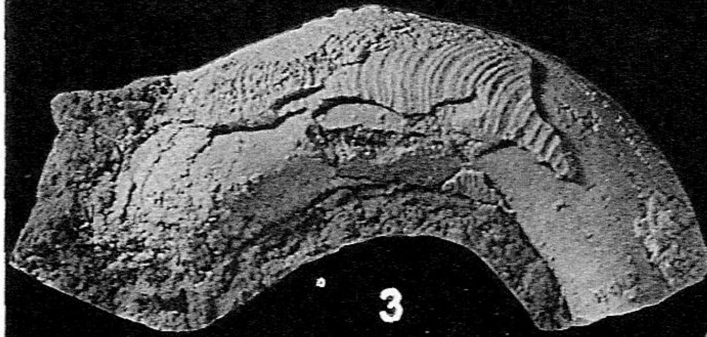

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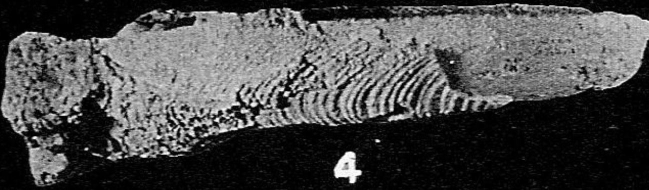

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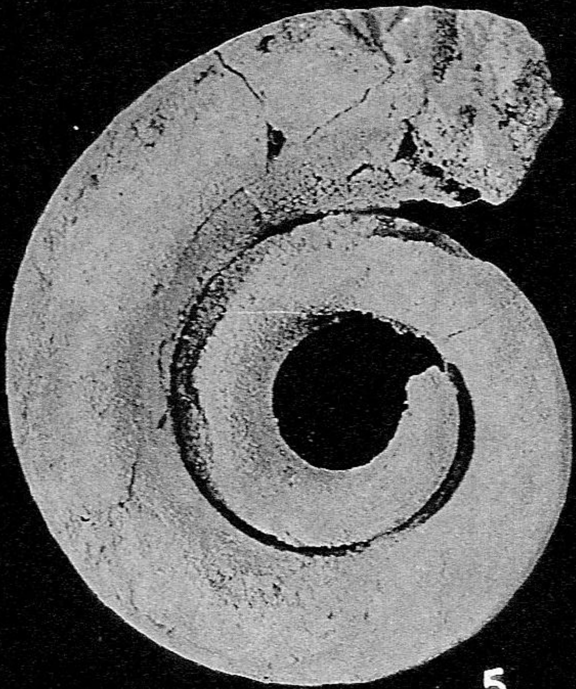

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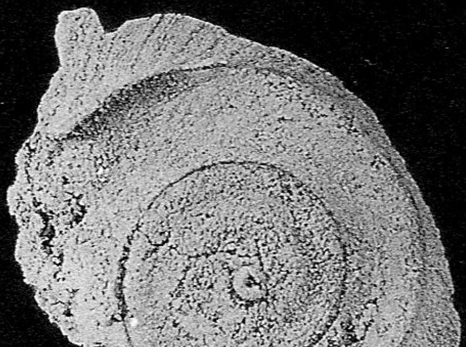

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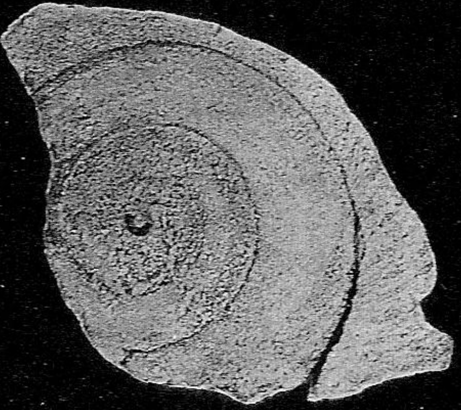

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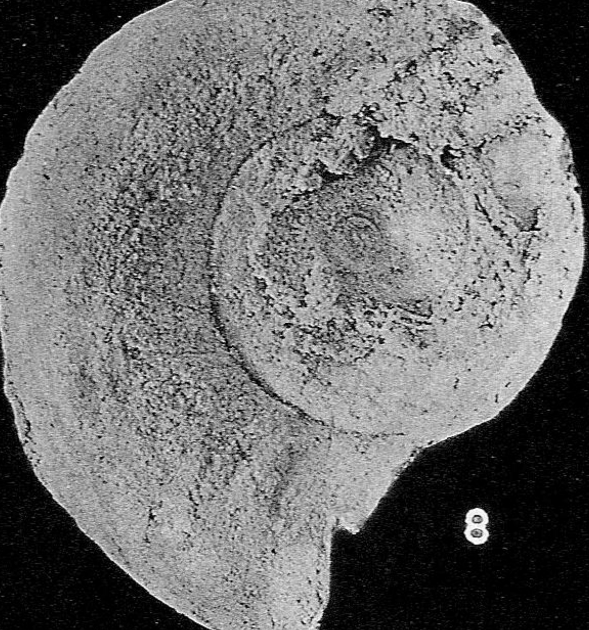

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PLATE XXIX.—**LESEURILLA**

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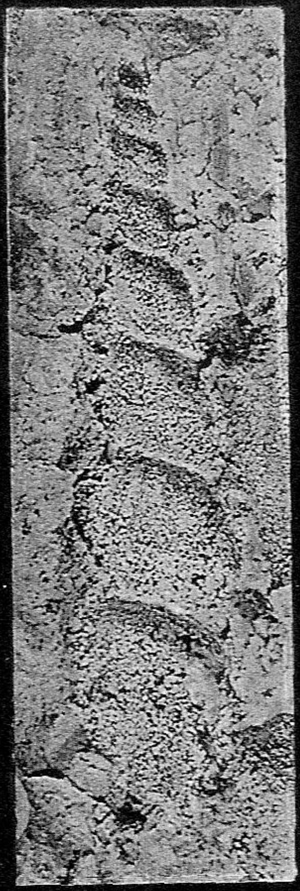
Leseurilla supraconvexa n. sp. -- 57

Figures 1-4. Holotype U. S. N. M. ----, dorsal, cross section of whorl, basal and lateral views of last whorl, Ulrich's locality 281b, X 1.

Leseurilla magna n. sp. -- 57

Figures 5-8. Holotype M. S. M. 7220, dorsal view of internal mould, ventral view of external mould of spire, dorsal view of rubber cast of external mould of the spire, ventral view of a rubber mould of the umbilicus, M. S. M. locality A5.6, X 1.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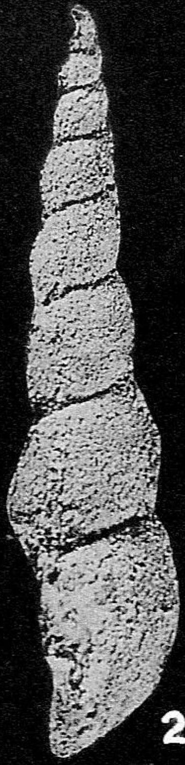
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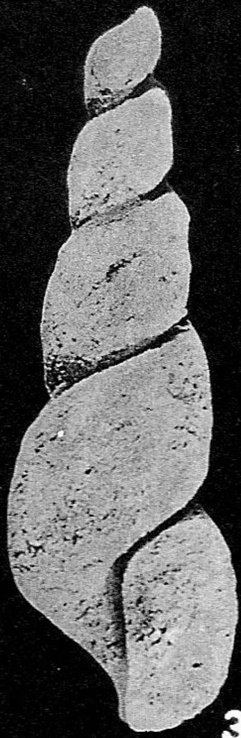
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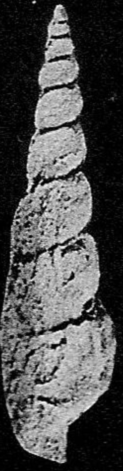
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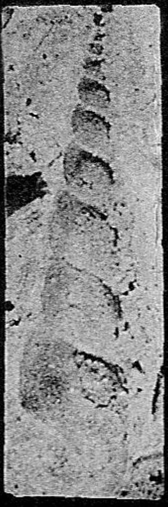
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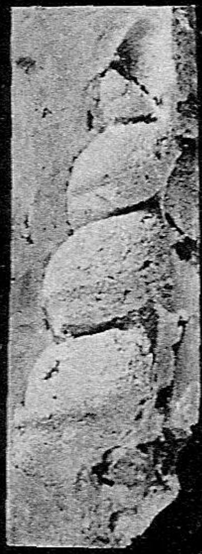
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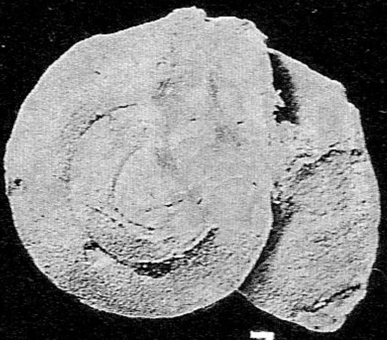
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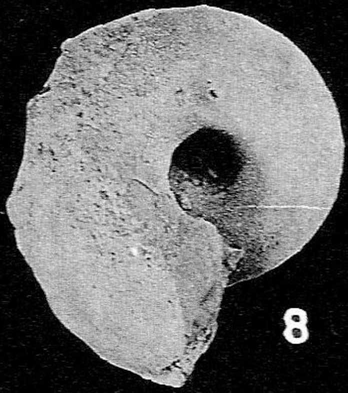
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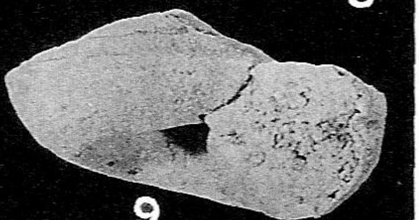
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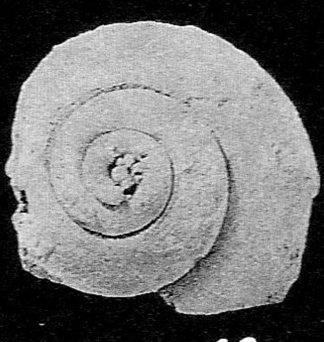
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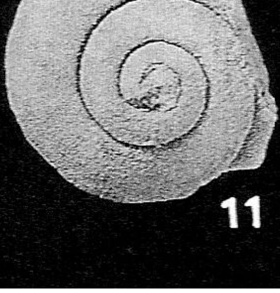
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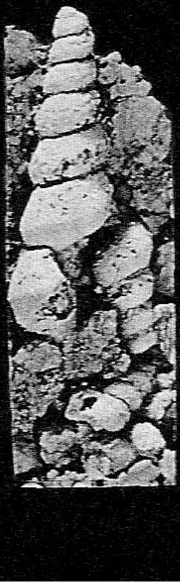
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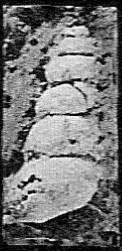
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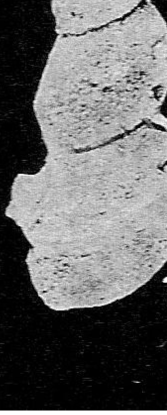
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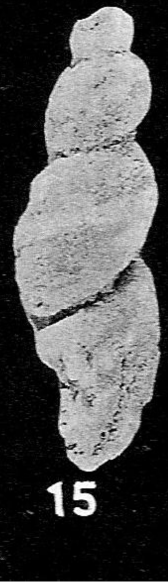
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PLATE XXX.—EOTOMARIA, HORMOTOMA

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Hormotoma powellensis n. sp. -- 60

Figures 1, 2. Holotype M. S. M. 7197, profile view of holotype (an external mould) and a rubber cast of the holotype, M. S. M. locality A5.6, X 1.

Figure 3. Paratype Y. P. M. 17151, profile view of an internal mould showing cross section of whorl, M. S. M. locality A5.6, X 1.

Hormotoma cotterensis n. sp. -- 59

Figures 4, 5. Holotype M. S. M. 7198, profile view of rubber cast of holotype and profile view of holotype, an external mould, M. S. M. locality 75.28, X 1.

Figure 6. Paratype Y. P. M. 17150, profile view of internal mould, M. S. M. locality 75.28, X 1.

Eotomaria depressa n. sp. -- 58

Figures 7-9. Holotype Y. P. M. 17146, dorsal, ventral, and profile views, M. S. M. locality 75.28, X 1.

Figures 10, 11. Paratype M. S. M. 7213 and M. S. M. 7214, dorsal views, M. S. M. locality 75.28, X 1.

Hormotoma lutiensis n. sp. -- 59

Figure 12. Holotype M. S. M. 7199, profile view of internal mould, M. S. M. locality 106.24b, X 2.

Figure 13. Paratype Y. P. M. 17148, profile view of internal mould, M. S. M. locality 106.24b, X 2.

Hormotoma dubia n. sp. -- 58

Figure 14. Holotype M. S. M. 7196, profile view showing rate of expansion and central band, M. S. M. locality 72.51, X 1.

Figure 15. Paratype Y. P. M. 17147, profile view, M. S. M. locality 57.1, X 1.

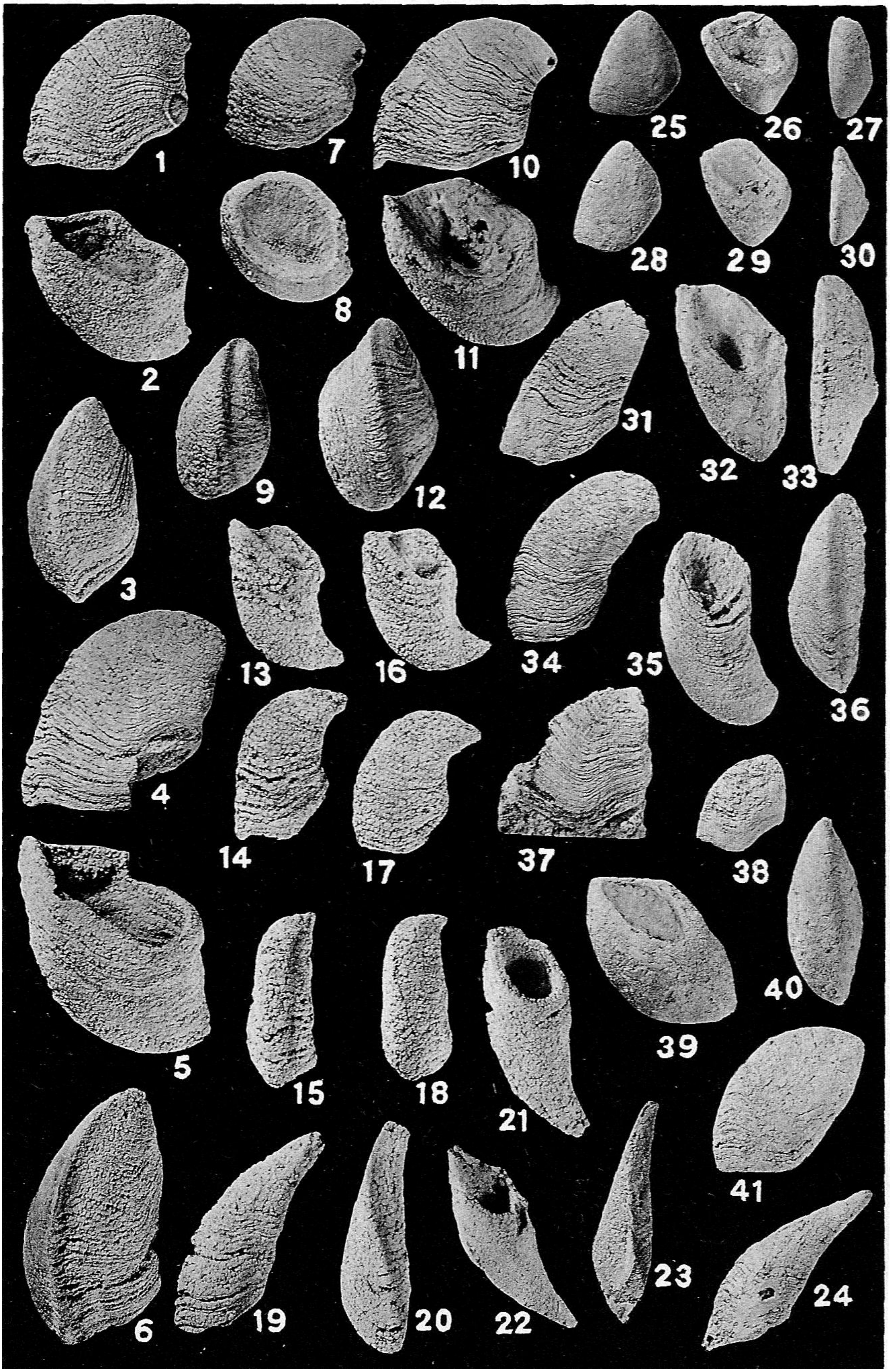
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PLATE XXXI.—**CERATOPEA**

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Ceratopea jenkinensis n. sp. -- 61

Figures 1-3. Holotype M. S. M. 7244, dorsal inclined apertural and carinal views, M. S. M. locality A4.2, X 1.

Figures 4-6. Paratype Y. P. M. 17157, dorsal inclined apertural and carinal views, M. S. M. locality A4.7, X 1.

Ceratopea capuliformis Oder -- 63

Figures 7-9. Hypotype Y. P. M. 17158, dorsal inclined apertural and carinal views, M. S. M. locality 75.23, X 2.

Figures 10-12. Hypotype M. S. M. 7246, dorsal, inclined apertural and carinal views, M. S. M. locality 75.23, X 2.

Ceratopea ankylosa n. sp. -- 61

Figures 13-15. Paratype Y. P. M. 17159, inclined apertural, dorsal and carinal views, M. S. M. locality A4.2, X 1.

Figures 16-18. Holotype M. S. M. 7247, inclined apertural, dorsal and carinal views, M. S. M. locality A4.2, X 1.

Ceratopea torta n. sp. -- 63

Figures 19-21. Paratype M. S. M. 7248, dorsal, carinal and inclined apertural views, M. S. M. locality 103.2, X 1.

Figures 22-24. Holotype Y. P. M. 17160, inclined apertural, carinal and dorsal views, M. S. M. locality 103.2, X 1.

Ceratopea supraplana n. sp. -- 64

Figures 25-27. Holotype Y. P. M. 17161, dorsal, inclined apertural and carinal views, M. S. M. locality 106.7, X 1.

Figures 28-30. Paratype U. S. N. M. ----, dorsal, inclined apertural and carinal views, M. S. M. locality 106.7, X 1.

Ceratopea jonesi n. sp. -- 63

Figures 31-33. Holotype M. S. M. 7249, dorsal inclined apertural and carinal views, M. S. M. locality 106.7, X 1.

Ceratopea subconica Oder -- 63

Figures 34-36. Hypotype M. S. M. 7250, dorsal inclined apertural and carinal views, M. S. M. locality 105.24, X 1.

Ceratopea tennesseensis Oder -- 62

Figure 37. Hypotype M. S. M. 7251, dorsal view, M. S. M. locality 75.19, X 1.

Figure 38. Hypotype Y. P. M. 17162, dorsal view, M. S. M. locality 75.19, X 1.

Ceratopea inflata n. sp. -- 64

Figures 39-41. Holotype M. S. M. 7252, apertural, carinal and dorsal views, M. S. M. locality A4.14, X 1.

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Plate XXXII

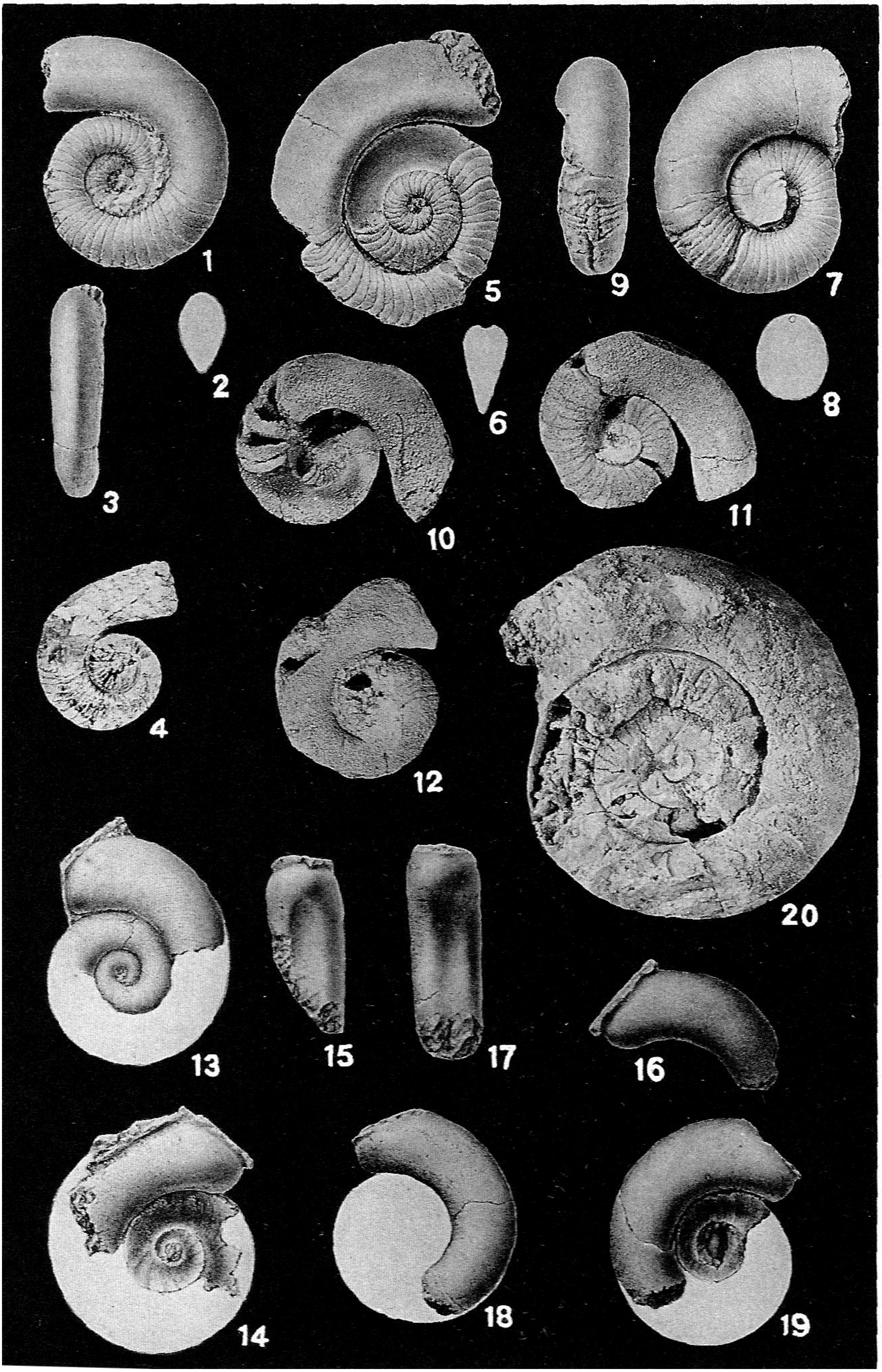


PLATE XXXII.—SHUMARDOCERAS, PILOTOCERAS, CAMPBELLOCERAS, MOREAUOCERAS, CENTROTARPHYCERAS

Page

Shumardoceras complanata (Shumard) Ulrich and Foerste ---------------- 64

Figures 1-3. Hypotype M. S. M. 7221, lateral, sketched cross sectional and ventral views retouched and supplied by A. K. Miller, M. S. M. locality 105.17, X 1.5.

Figure 4. Hypotype Y. P. M. 17127, lateral view (not retouched) M. S. M. locality 106.25b, X 1.

Pilotoceras brunei n. sp. -- 68

Figures 5, 6. Holotype M. S. M. 7222, lateral and cross sectional sketch, retouched and supplied by A. K. Miller, M. S. M. locality 72.42, X 1.5.

Campbelloceras simplex n. sp. -- 66

Figures 7-9. Holotype M. S. M. 7223, lateral, cross sectional and ventral views supplied and retouched by A. K. Miller, M. S. M. locality 75.28, X .5.

Shumardoceras Lutiensis n. sp. -- 65

Figure 10. Holotype M. S. M. 7224, lateral view, M. S. M. locality 106.25b, X 1.

Figure 11. Paratype Y. P. M. 17128, lateral view, M. S. M. locality 106.25b, X 1. (Slightly retouched.)

Figure 12. Paratype U. S. N. M. ----, lateral view, M. S. M. locality 106.25b, X 1. (Slightly retouched.)

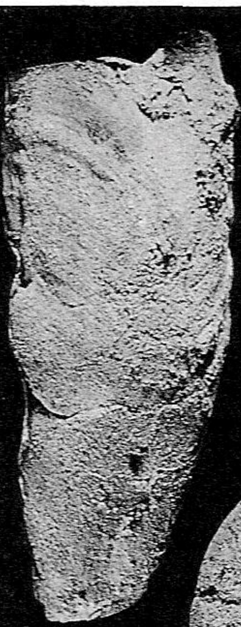
Moreauoceras milleri n. sp. -- 68

Figures 13-16. Holotype Y. P. M. 17129, (13) lateral view of rubber cast of external mould, (14) lateral view of partial internal and external moulds, (15) dorsal view of adoral portion of internal mould, (16) lateral view of adoral portion of internal mould, M. S. M. locality 57.1, X 1.5.

Figures 17-19. Paratype M. S. M. 7225, (17) dorsal view of adoral portion of living chamber, (18 and 19) lateral view of partial internal mould and of partial internal and external moulds, M. S. M. locality 57.1, X 1.5. (Figures retouched and supplied by A. K. Miller.)

Centrotarphyceras yellvillensis Ulrich, Foerste, Miller and Furnish (Mss) --- 67

Figure 20. Hypotype Y. P. M. 17152, lateral view, M. S. M. locality A5.6, X .5.



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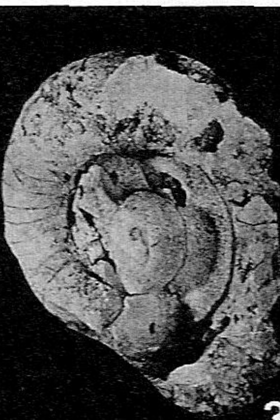

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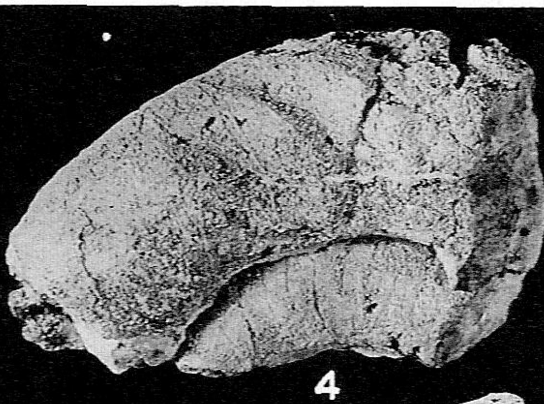

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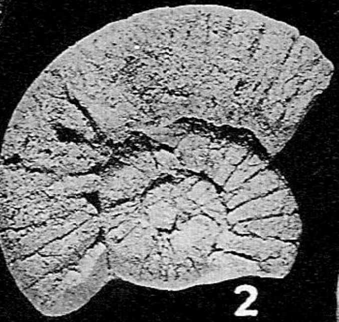

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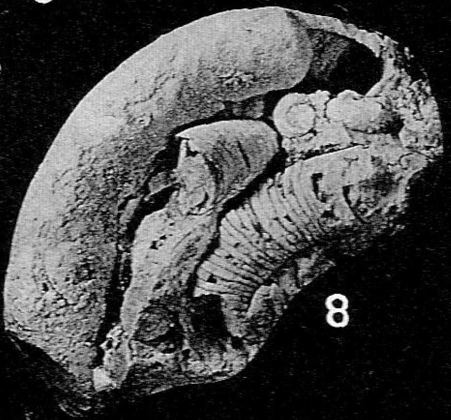

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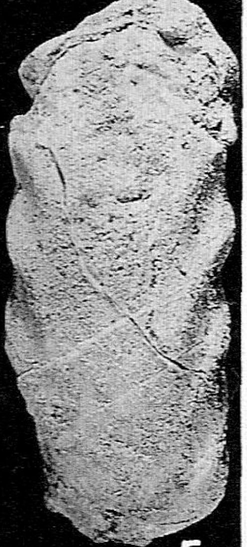

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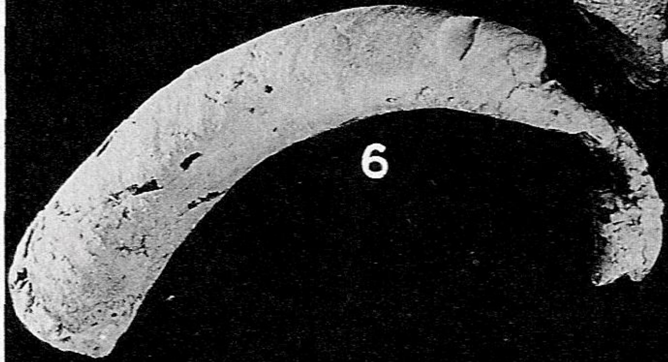

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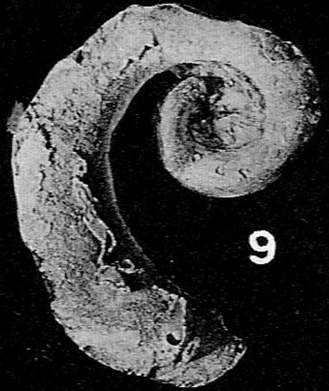

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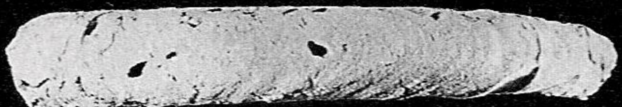

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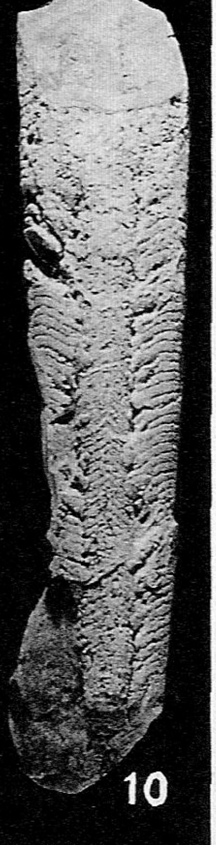

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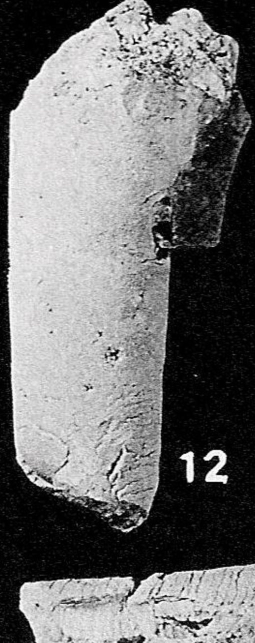

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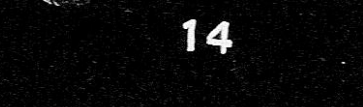

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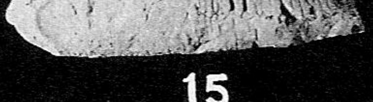

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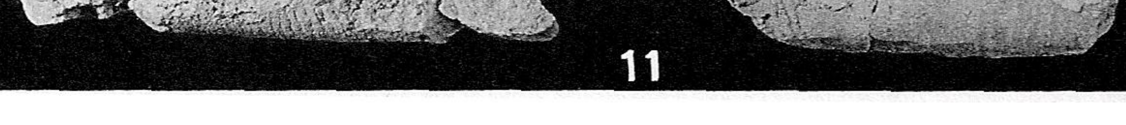

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PLATE XXXIII.—CENTROTARPHYCERAS, APHETOCERAS, CYPTENDOCERAS and DYSCRITOCERAS

Page

Centrotarphyceras yellvillensis Ulrich, Foerste, Miller, and Furnish (Mss) ---- 67

Figure 1. Hypotype Y. P. M. 17153, ventral view of a rubber cast of external mould of living chamber showing growth lines. M. S. M. locality A5.6, X .5.

Figure 2. Hypotype M. S. M. 7236, lateral view of apical portion of phragmacone, M. S. M. locality A5.6, X .5.

Figure 3. Hypotype M. S. M. 7237, slightly inclined lateral view showing location of siphuncle, M. S. M. locality A5.6, X .5.

Centrotarphyceras (?) *baxterensis* n. sp. ---- 67

Figures 4, 5. Holotype M. S. M. 7238, lateral and ventral views showing nodes on internal mould of living chamber, M. S. M. locality A5.6, X .5.

Aphetoceras subcostulatum Ulrich, Foerste, Miller and Furnish (Mss) ---- 65

Figures 6, 7. Hypotype M. S. M. 7239, lateral and ventral views of living chamber and a fragmentary part of phragmacone, M. S. M. locality 72.51, X .5.

Figure 8. Hypotype, Y. P. M. 17154, lateral view of almost complete living chamber and adoral portion of phragmacone, also two fragments of two other specimens of the same species, showing sutures and camerae, M. S. M. locality 72.51, X .5.

Figure 9. Hypotype M. S. M. 7240, lateral view of a rubber cast of an external mould, showing method of coiling, M. S. M. locality 72.51, X .5.

Cyptendoceras magnus n. sp. ---- 69

Figure 10. Holotype Y. P. M. 17155, ventral view showing siphuncle, M. S. M. locality 75.28, X .5.

Figure 11. Paratype M. S. M. 7241, ventral view of oriented fragmentary specimen, M. S. M. locality 75.28, X .5.

Figure 12. Paratype Y. P. M. 17156, ventral view of almost complete living chamber and adoral portion of phragmacone, M. S. M. locality 75.28, X .5.

Aphetoceras ozarkensis n. sp. ---- 66

Figure 13. Holotype M. S. M. 7242, lateral view, M. S. M. locality 72.51, X .5.

Dyscritoceras jeffersonensis n. sp. ---- 69

Figures 14, 15. Holotype M. S. M. 7243, lateral and ventral views. M. S. M. locality 75.42, X .5.

PLATE XXXIV.—JEFFERSONIA, BATHYURELLUS, BOLBOCEPHALUS, ROLLIA, RANANASUS, HYSTRICURUS

Jeffersonia producta n. sp. ---- 73

Figures 1, 2, 5. Holotype U. S. N. M. ----, dorsal, anterior, and profile views of cranidium, Ulrich's locality 283c, X 1.

Figure 3. Paratype Y. P. M. 17163, dorsal view of anterior portion of cranidium, M. S. M. locality 72.50, X 1.

Figure 4. Paratype M. S. M. 7171, dorsal view of cranidium, M. S. M. locality 72 50, X 1.

Figure 6. Paratype M. S. M. 7264, free cheek, M. S. M. locality 72.50, X 1.

Figure 7. Paratype Y. P. M. 17164, dorsal view of pygidium slightly crushed, M. S. M. locality 67.2, X 1.

Figures 8, 9. Paratype U. S. N. M. ----, dorsal and lateral views, Ulrich's locality near Rolla, Missouri, X 1.

Jeffersonia missouriensis n. sp. ---- 71

Figures 10, 12. Holotype Y. P. M. 17166, dorsal, anterior and profile views, M. S. M. locality 72.50, X 1.

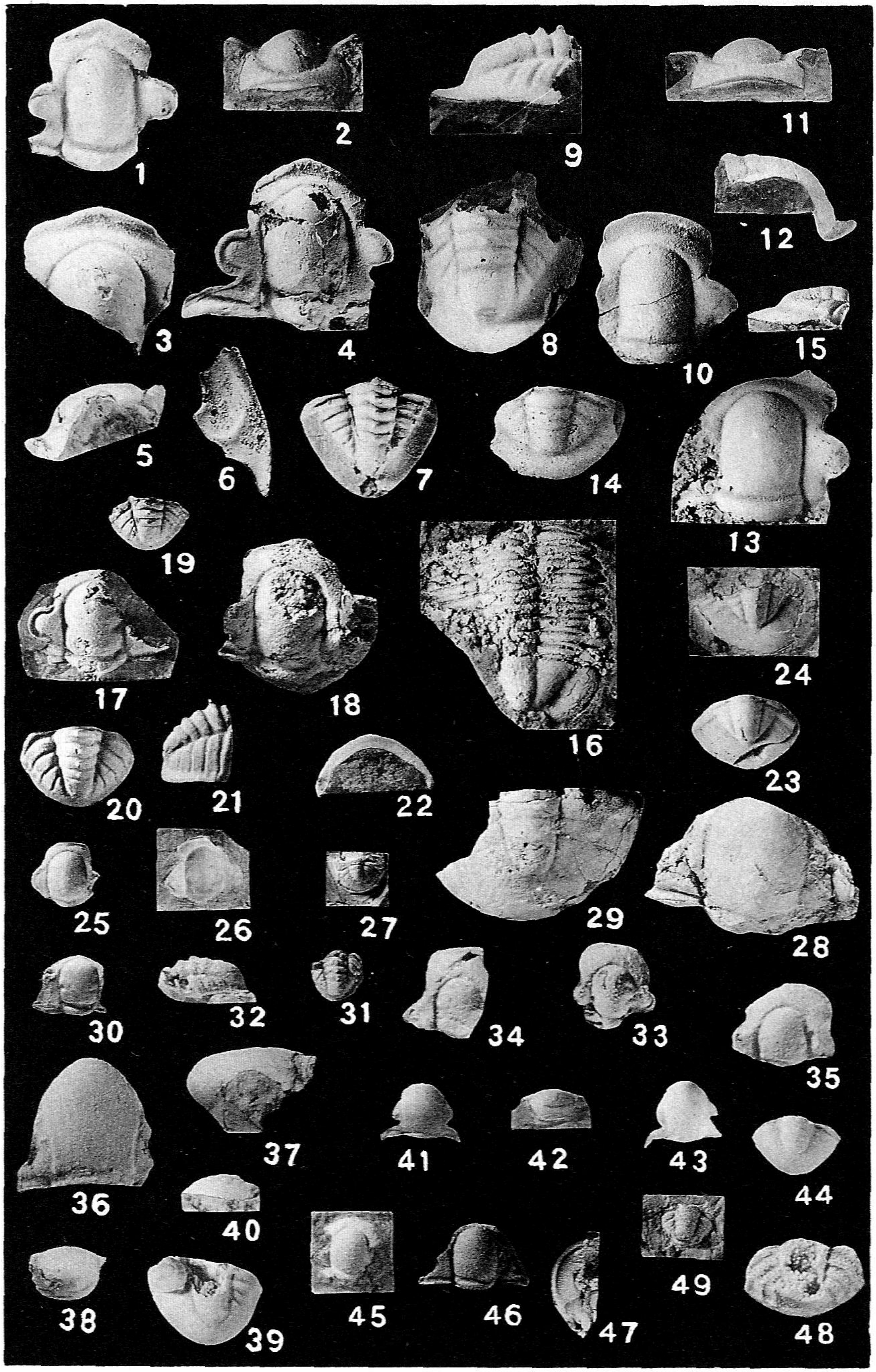
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Figure 13. Paratype U. S. N. M. ----, dorsal view, Ulrich's locality 101s, X 1.

Figures 14, 15. Paratype U. S. N. M. ----, dorsal and profile views, Ulrich's locality 101s, X 1.

Figure 16. Paratype M. S. M. 7180, rubber cast of external mould of part of thorax and pygidium, M. S. M. locality 105.25, X 1.

Jeffersonia granosa n. sp. -- 72

Figure 17. Holotype U. S. N. M. ----, dorsal view, Ulrich's locality 101s, X 1.

Figure 18. Paratype M. S. M. 7168, dorsal view, M. S. M. locality 72.46, X 1.

Figure 19. Paratype U. S. N. M. ----, dorsal view, Ulrich's locality 101s, X 1.

Figures 20-22. Paratype M. S. M. 7169, dorsal, profile and ventral views, M. S. M. locality 72.50, X 1.

Bathyurellus permarginatus n. sp. -- 70

Figure 23. Holotype Y. P. M. 17170, dorsal view, M. S. M. locality 72.50, X 1.

Figure 24. Paratype M. S. M. 7165, dorsal view, M. S. M. locality 72.50, X 1.

Jeffersonia mediacrista n. sp. -- 74

Figures 25, 26. Holotype U. S. N. M. ----, dorsal view of cranidium, ventral view of external mould of cranidium, Ulrich's locality 273d, X 1.

Figure 27. Paratype U. S. N. M. ----, dorsal view of pygidium, Ulrich's locality 273d, X 1.

Bolbocephalus jeffersonensis n. sp. -- 77

Figure 28. Holotype M. S. M. 7181, dorsal view of cranidium, M. S. M. locality 72.50, X 1.

Figure 29. Paratype M. S. M. 7182, dorsal view of pygidium, M. S. M. locality 72.50, X 1.

Jeffersonia delicatula n. sp. -- 75

Figure 30. Holotype U. S. N. M. ----, dorsal view of cranidium, Ulrich's locality 363s, X 1.

Figures 31, 32. Paratype U. S. N. M. ----, profile and dorsal views of pygidium, Ulrich's locality 363s, X 1.

Rollia goodwini n. sp. -- 81

Figure 35. Holotype U. S. N. M. ----, dorsal view, M. S. M. locality 72.46, X 2.

Figure 33. Paratype Y. P. M. 17175, dorsal view of cranidium, M. S. M. locality 72.50, X 2.

Figure 34. Paratype M. S. M. 7186, dorsal view of cranidium, M. S. M. locality 57.1, X 2.

Rananasus conicus n. sp. -- 82

Figures 36-38. Holotype U. S. N. M. ----, dorsal, lateral and anterior views of cranidium, M. S. M. locality 72.38a, X 2.

Figures 39, 40. Paratype U. S. N. M. ----, dorsal and lateral views of pygidium, M. S. M. locality 72.38a, X 2.

Rananasus brevicephalus n. sp. -- 82

Figures 41, 42. Holotype U. S. N. M. ----, dorsal and anterior views of cranidium, M. S. M. locality 106.2, X 2.

Figure 43. Paratype M. S. M. 7189, dorsal view of cranidium, M. S. M. locality 75.23, X 2.

Figure 44. Paratype M. S. M. 7190, dorsal view of pygidium, M. S. M. locality 72.50, X 2.

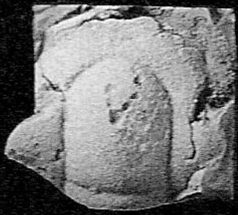
Hystricurus abruptus n. sp. -- 80

Figures 48, 49. Holotype U. S. N. M. ----, postero-dorsal view showing ridges across margin X 2, and similar view of wax cast of external mould of figure 48, M. S. M. locality 72.50, X 2 and X 1 respectively.

Figure 45. Paratype U. S. N. M. ----, dorsal view of cranidium, M. S. M. locality 72.50, X 2.

Figure 46. Paratype Y. P. M. 17176, dorsal view, M. S. M. locality 72.50, X 2.

Figure 47. Paratype M. S. M. 7256, dorsal view of free cheek, M. S. M. locality 72.50, X 2.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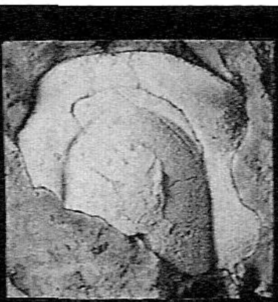
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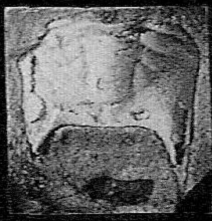
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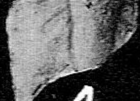
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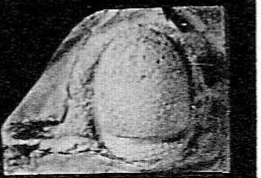
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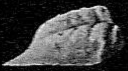
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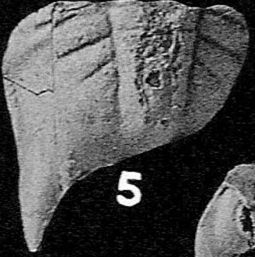
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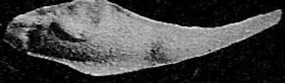
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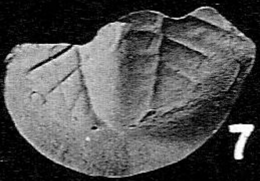
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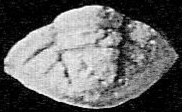
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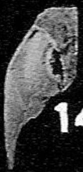
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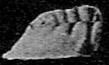
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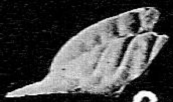
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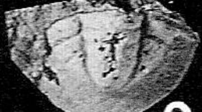
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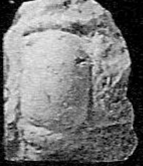
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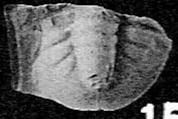
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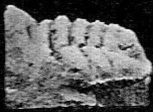
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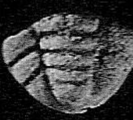
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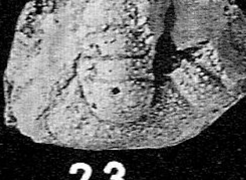
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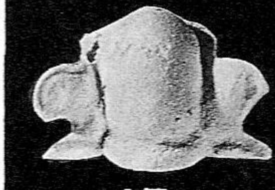
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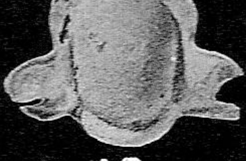
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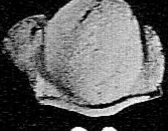
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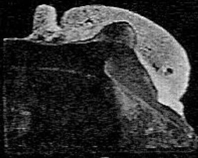
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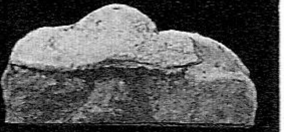
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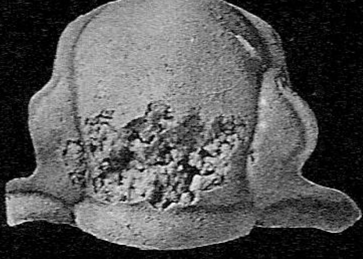
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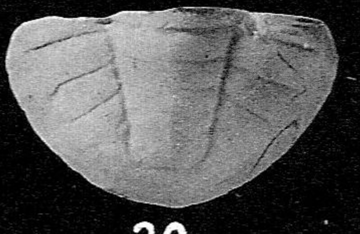
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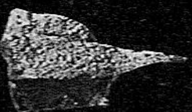
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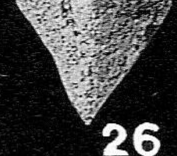
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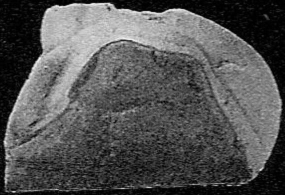
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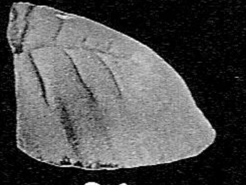
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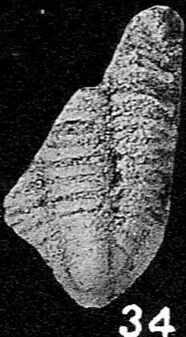
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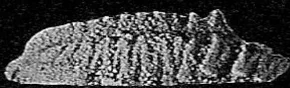
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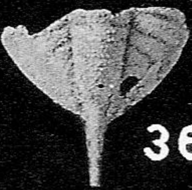
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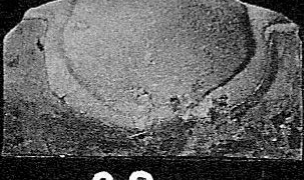
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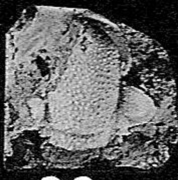
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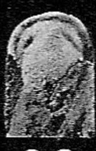
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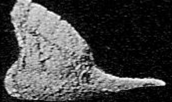
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PLATE XXXV.—LUTESVILLIA, HYSTRICURUS, JEFFERSONIA, BOLBOCEPHALUS, GONIOTELUS

Page

Lutesvillia bispinosa n. sp. -- 79

Figure 1. Holotype, U. S. N. M. ----, dorsal view of cranidium, Ulrich's locality 102k, X 1.

Figure 2. Paratype U. S. N. M. ----, dorsal view of cranidium, Ulrich's locality 102k, X 1.

Figure 3. Paratype U. S. N. M. ----, dorsal view of pygidium, Ulrich's locality 102k, X 1.

Figure 4. Paratype M. S. M. 7185, dorsal view of pygidium, M. S. M. locality 88.1, X 1.

Figure 5. Paratype U. S. N. M. ----, dorsal view of pygidium, Ulrich's locality 102k, X 1.

Figure 6. Paratype U. S. N. M. ----, dorsal view of wax cast of external mould of free cheek, Ulrich's locality 102k, X 1.

Jeffersonia sp. 2 -- 77

Figures 7, 8. U. S. N. M. ----, dorsal and profile views of wax cast of external mould, Ulrich's locality 438u just above the building rock at Jefferson City, Missouri, X 1.

Jeffersonia sp. 1 -- 77

Figures 9, 10. U. S. N. M. ----, dorsal and profile views, Ulrich's locality 456z, X 1.

Hystricurus cf conicus Billings --

Figures 11, 12. M. S. M. 7257, dorsal view of cranidium and of pygidium, M. S. M. locality 75.23, X 2.

Jeffersonia crassimarginata n. sp. -- 75

Figure 13. Paratype Y. P. M. 17178, dorsal view of cranidium, M. S. M. locality 105.18, X 1.

Figure 14. Paratype Y. P. M. 17179, dorsal view of free cheek, M. S. M. locality 105.18, X 1.

Figures 15, 16. Holotype Y. P. M. 17177, dorsal and profile views of pygidium, M. S. M. locality 106.11, X 1.

Jeffersonia jennii n. sp. -- 76

Figures 17-19. Holotype Y. P. M. 17180, dorsal, antero-dorsal and profile views, M. S. M. locality 75.28, X 1.

Figure 20. Paratype U. S. N. M. ----, anterior view showing frontal margin and brim, M. S. M. locality 75.28, X 1.

Figures 21, 22. Paratype Y. P. M. 17181, lateral and dorsal views of pygidium, M. S. M. locality 75.28, X 1.

Gen. (?) *Sp* (?) -- 84

Figures 23, 24. Figured specimen M. S. M. 7258, dorsal and posterior views, M. S. M. locality 106.11, X 1.

Goniotelus semicircularis n. sp. -- 84

Figures 25, 26. Holotype Y. P. M. 17182, profile and dorsal views of internal mould, M. S. M. locality A4.8, X 1.

Bolbocephalus st. clairi n. sp. -- 78

Figures 27, 28, 29. Holotype U. S. N. M. ----, dorsal, profile and ventral views of cranidium, Ulrich's locality 397o, X 1.

Figures 30, 31. Paratype U. S. N. M. ----, dorsal and profile views of pygidium, Ulrich's locality 397o, X 1.

Goniotelus marionensis n. sp. -- 83

Figure 32. Holotype U. S. N. M. ----, dorsal view of cranidium, Ulrich's locality 101k, X 1.

Figure 33. Paratype M. S. M. 7192, ventral view of hypostoma, M. S. M. locality A4.8, X 1.

Figure 34, 35. Paratype U. S N M ----, dorsal and lateral views of thorax and pygidium, Ulrich's locality 474q, X 1.

Figures 36, 37. Paratype U. S. N. M. ----, dorsal and lateral views of pygidium showing caudal spine, Ulrich's locality 101k, X 1.

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